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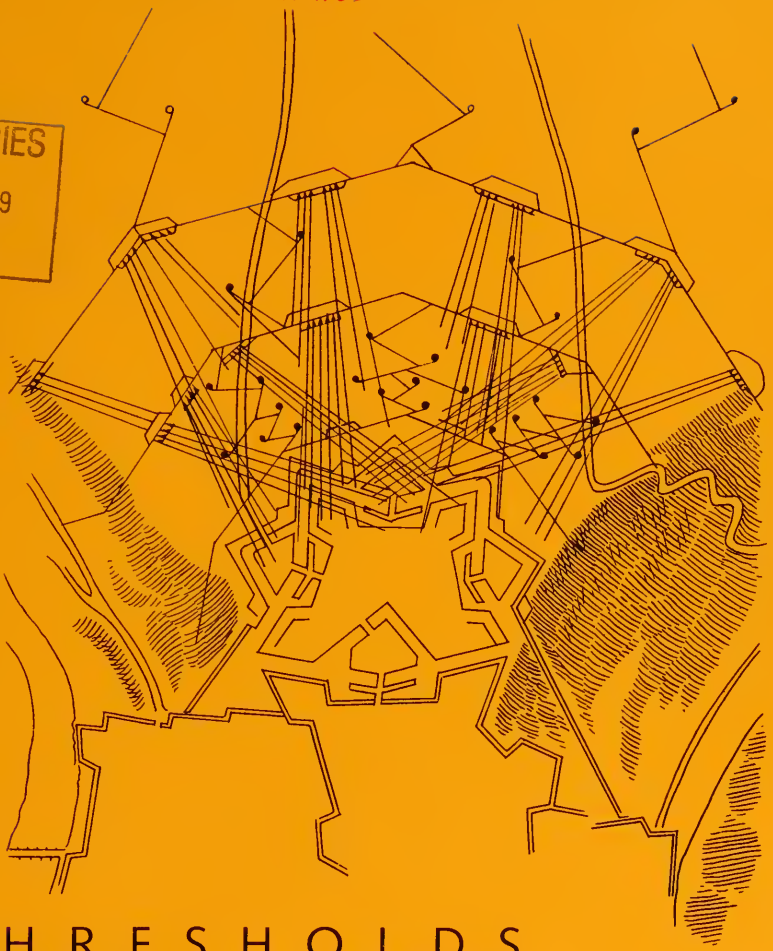

THRESHOLDS

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY
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Editors: Edward Eigen and Lia Kiladis

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"A Shifting Reef," the opening chapter of science fictionalist Jules Verne's novel *20,000 Leagues Under the Sea* (1870), describes "a strange event, an unexplainable occurrence which is undoubtedly still fresh in everyone's mind." This vague occurrence was the siting—or more accurately, the report—of an "enormous thing," one of "surprising power of locomotion," especially remarkable for the "strange life with which it was endowed." Indeed, the malignant Captain Nemo's *Nautilus* was an entity literally traveling beneath the surface of classification. The offending vessel ruptured the thresholds separating animal and machine, path and place, sheltering environment and the excluded medium through which it traveled. All the while the popular press disputed whether the thing was Moby Dick, naturalists argued which genus it belonged to, and ships' captains were menaced by its cross-current movements which they could not account for in their log books. The *Nautilus* embodied the hybrid nineteenth century birth of three fundamental forces and forms: life, energy, and information. This strange event, "so fresh in everyone's mind," also bears all the signs and characters of modernity. As Verne showed, the "shifting reef," a commixtion of water and land, can not be given an absolute measure, but can only be gauged in terms of phase change, movement, growth, and decay.

This issues of *Thresholds* examines the context of what the environmental historian William Cronon calls "second nature"; a topography crisscrossed by biological, mechanical, and cultural technologies which is neither purely natural or artificial. Our contributors have focused on diverse interactions and exchanges within this rapidly changing milieu. Paula Findlen examines the role of collecting, ordering, and knowing in mediating our relationship to objects and interior space. Peter Galison raises critical issues related to the overlapping "contexts" of science and architecture. David Mindell sheds light on rarely seen terrain in search of a historic-geography of warfare. Rosalind Williams describes the role of Verne's literary vehicles in traversing the representational spaces of modernity. Amy Slaton examines the role scientific and professional expertise play in the perception of the materials and manufacture. The final essay is the editor's opinionated appreciation of some forms of interactivity not yet available on CD-ROM.

Photograph by Peter Tolkin

Paula Findlen

Containment:

Objects, Places, Museums

Museums, as Robert Harbison suggested almost twenty years ago, are "eccentric spaces."[1] By incorporating museums into his category of eccentric spaces, Harbison invested them with a certain malleability bordering on deformation. Harbison's museum became the terminus for a myriad of culture-bound activities: it stored, classified and displayed objects; it created culture; it imagined the past. In the final result, the museum neutralized all meaning surrounding objects prior to their museological existence. History both began and ended in the museum, a chronology of existences spread out across rooms but having no bearing on the world outside the museum itself. "The result museums seek is an end to change, a perfect statis or stillness," wrote Harbison. "They are the final buildings on earth."[2]

While we may no longer see Harbison's apocalyptic view of the museum as the last human institution as a definitive explanation of its significance, this dissatisfaction is in itself a sign of how much contemporary as well as historical analysis of museums has changed. Twenty years later, museum studies are much more likely to adopt the theoretical work of Jean Baudrillard regarding the "system of objects" or the writings of Pierre Bourdieu on the history of taste to explain the importance of museums. One of the most recent books on the history of collecting, Eilean Hooper-Greenhill's *Museums and the Shaping of Knowledge* (1992) takes Michel Foucault's *The Order of Things* as its point of departure.[3] Perhaps we could say that this shift represents a preference for analytical models that emphasize the classificatory aspects of museums, whether they focus on the literal mapping of knowledge or its social, political and cognitive uses. Such tendencies are summed up in Krzysztof Pomian's presentation of the history of museums as a subset of the history of *semiophores*, which he defines as "objects bearing meaning."[4] Thus the museum itself becomes a larger version of the thing it embraces.

Without denegrating all the fine work done on the history of collecting, following these various French models, I want to recover a small piece of Harbison's project and perhaps bring it in line with these other attempts to analyze the cultural meaning of museums. For, in the decision to emphasize the knowledge-making aspects of the museum, its spatial features frequently are neglected. We know a great deal about how museums reflected shifts in knowledge but significantly less about what the museum itself was. Harbison's museum is a janus-faced structure: a profoundly canonical setting with the potential for uncanonical meanings, hence the label "eccentric space." Somewhere between the prehistory of the museum and the appearance of such phrases as the "museum without walls" (a clear reaction to the canon) lies a story about our attempts to spatially distinguish the museum from a variety of other settings that contained things (but not necessarily nature or culture, history or community, some of the primary objects and concepts placed in museums). This essay offers some brief reflections on the development of the edifice that we call a museum. In elaborating on the origins of the museum in western culture, the following questions might serve as a useful guide: First, how did we demarcate the "museum" from a variety of other settings in which valuable objects were stored? Second, as the museum increasingly became a distinct location, how did it emerge as a largely autonomous and essentially public institution that displayed objects as much as it housed them? Finally, what does it mean to house knowledge?

Figure 1 The study of Francesco Petrach at Arquà

Emptying the Museum

Let us reverse the museum. Remove the objects, return them to the outside. What remains? A room, a series of rooms, boxes without things, labels pointing nowhere, the unquiet emptiness of a container that needs to be filled. Of course we might reasonably conclude, as a result of this exercise, that the museum lies in the objects and accordingly travels with them wherever they go. But this is only partially true. It is the dynamic interaction between objects and structures that defines the museum (in a sense the museum might be defined, quite simply, as "things in their place"). While the museum is a unique accrual of objects turned artifacts, it is also a special structure. We know this because when we *see* a museum we, most often, intuitively recognize it for *what it is*.

Let us now remove the museum from the Museum. While this is its current resting point, the institution of the Museum is not the museum's point of origin. Prior to the nineteenth century the majority of museums were hardly separate edifices. Rather than being a public imperative, they were the intimate purvue of the cultured elite. While collecting generally was a mark of refinement—it provided one of the quintessential definitions of taste[5]—the possession of a museum—a collection that had earned some measure of public recognition—conferred added social status. Such activites were particularly visible in western Europe where early urbanization, the emergence of a competitive social elite, the growing emphasis on cultured pursuits among the upper classes, and a passion for objects as an expression of wealth and power all contributed to the formation of the museum.[6] In the Middle Ages reliquaries and princely treasuries were the primary settings for the housing of special objects. They also limited collecting to a very small sector of society and defined it in relationship to fairly specialized functions. During the Renaissance the desire to collect became a more general pursuit of the urban, educated elite. The growing passion for antiquities, the increase in books with the advent of printing, the influx of objects from non-Western regions (particularly Spanish America and Asia), and new historical sensibilities (making objects a marker of time as well as place) all contributed to the design of the museum. Thus by the sixteenth century, Europeans had begun to make space for special objects, imagining the museum into existence.

A Trail of Objects

In the first half of the fourteenth century, the Italian humanist Francesco Petrarch began his search for the honorable past of the Romans as an antidote to the dishonorable epoch he polemically labeled the "Dark Ages." Like many early Renaissance humanists, he scoured the monastic libraries of Europe for lost manuscripts, treasuring the ones he could not read because they were in Greek as much as the ones he could understand in Latin. He looked at the fragments of antiquity scattered throughout the papal city with a new eye, coveting them not simply because they were beautiful but because they evoked a past he wished to recover. These talismans of civilization all found their way into the studies of early humanists. By the fifteenth century collectors of antiquities abounded throughout Europe, trading objects, sometimes jealously guarding their finds from each other, and traveling beyond Rome in search of the past they hoped to possess.[7]

The early humanists embraced collecting but they had not yet found the museum.[8] A comparison of two images serves to illustrate this point. Let us consider Petrarch's study in his country villa at Arquà. [Fig.1] Of course the modern photograph, a museum artifact in its own right since it purports to re-create the experience of Petrarch's scholarship, is deceptive because it completely empties Petrarch's study (in effect, creating the very museum I described earlier in this essay). This is the barren cell of knowledge *sui generis*. Yet we know from contemporary depictions of Petrarch's study that there were probably objects within it—books, manuscripts, papers, a religious artifact or two, and perhaps a piece of Rome to gaze upon.[9] In other words, Petrarch did not shun objects, he coveted them.

Yet even imagining the objects of Petrarch's study back into it does not transform the study into the museum. The shallow niches in the walls surely held a few things but not many. Perhaps Petrarch had a chest or two installed in the room to contain the remainder but we know that this sort of furniture was used sparingly if at all in the fourteenth century. In other words, while the room is not as bare as it initially seems, it is still a setting that does not emphasize objects *over contemplation*. Petrarch's study continues the tradition of St. Augustine and St. Jerome, wise men who retreated to the study, at least as medieval and Renaissance iconography would have it, in order to commune with God. Secular concerns—and surely Petrarch would not even have understood what this meant—cannot take precedence over spiritual affairs. The study in its solitude celebrates the *vita contemplativa*, removing its occupant from the world.

Cornucopia

Three centuries later, much had changed. By the seventeenth century the museum had become a standard feature of European cultural life. Visitors toured Europe in search of new museums to see and recorded their visits in travel journals, a new genre of writing that primarily revealed how formulaic visits to museums had become. Consider the report of the anonymous "English Gentleman" who, in 1675, offered his

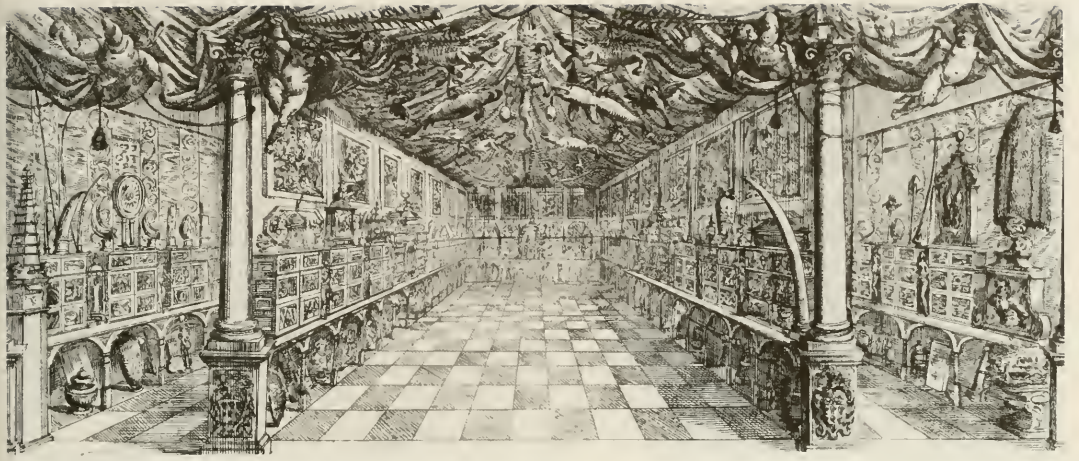

Figure 2 The gallery of Manfredo Settala in Milan

readers *A Tour in France and Italy*. The most prominent word in his lengthy description of one museum is "etc."[10] In the final assessment, despite his praise for the collection, he had seen it all before. Petrarch's wonder at the objects that lay in front of him had given way to the dulled sensibilities of the tourist who already knew what he was about to see before it had been seen.

The Italy that Petrarch found filled with ancient objects had become the premier location for the museum-going public, undoubtedly because the Italians felt they had a special relationship to the first objects Renaissance Europeans chose to collect. If antiquity was housed in Italy, the special patrimony of Rome, then ostensibly *all* Italy was a museum.[11] Such sentiments, coupled with the social aspirations of Italian patricians who prided themselves more and more on their culture (as the political and economic status of the Italian states diminished in the face of absolutist monarchies and overseas empires), fostered what we might perhaps terms as the first museum culture. "There is certainly no place in the world, where a man may travel with greater pleasure and advantage than Italy . . . ," reported Joseph Addison in 1705. "It abounds with cabinets of curiosities, and vast collections of all kinds of antiquities."[12] A decade earlier, Maximilian Misson had already defined the museum-goer as a distinctive type of traveler: "Of those who travel into Italy, . . . some. . . mind nothing but Libraries, and Cabinets of Curiosities."[13] Italy was perhaps the first region to provide travelers with an itinerary of museums that became as distinctive feature of its cultural identity as the cupola of Florence, the prostitutes of Rome or the gondolas of Venice.

Unbound objects

We have arrived in Milan, ca. 1670. What should we see? Visitors today might head immediately for the Duomo or try their Italian out on the sales clerks at Benetton, but their early modern counterparts knew that the most interesting site in the city was contained in three rooms of the family palace occupied by the canon of San Nazaro, Manfredo Settala. Studious and inventive, Settala had been a protegé of the Medici family during his student days at the University of Pisa (where he had undoubtedly acquired his predilection for Galilean telescopes and cultivated his interest in mechanical toys). His passion for books and exotic missionary artifacts had been nurtured under the patronage of Federico Borromeo, Archbishop of Milan and owner of one of the largest libraries and art galleries in early seventeenth-century Europe. By the 1660s Settala had become one of the most prominent collectors in Italy. Even after his death in 1680, people continued to visit the museum for almost a century until, finally, the objects were removed from the family palace to the Biblioteca Ambrosiana, where some of them may still be seen today.[14]

Examining the engraved image of the museum in the Italian edition of Paolo Terzago's *Museum or Gallery Assembled from Knowledge and from the Study of Signor Canon Manfredo Settala, Milanese Noble* (1666), we find ourselves in a different space altogether than that inhabited by Petrarch.[15] [Fig.2] While both share the concept of the "study," the original study has been transformed. Deformed beyond all recognition, it is in the process of becoming Harbison's eccentric space. We cannot imagine away the objects in these three rooms, even though we know that their depiction is idealized and, to some degree, imaginary. In Settala's ideal museum, a utopia for objects, several *putti* draw back the curtain to reveal the museum. The objects on the ceiling seem so near that we can almost touch them. In fact,

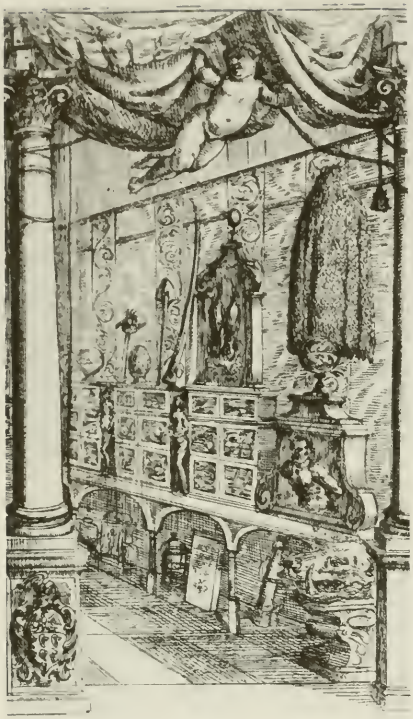

Figure 3 The Tupinamba cape in Settala's museum

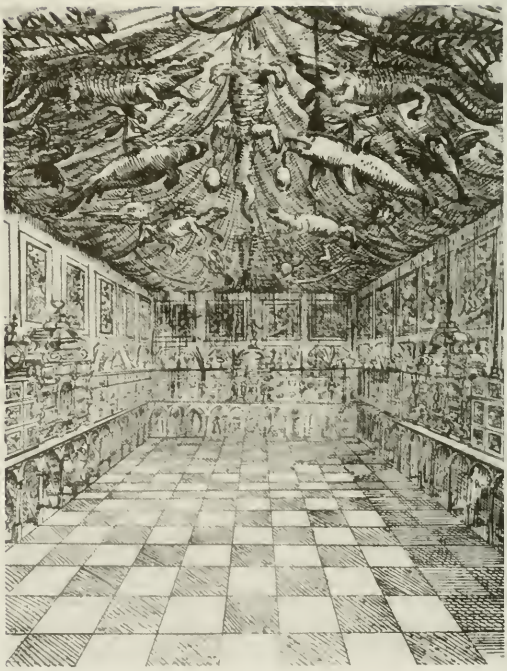

Figure 4 The crocodile's view of Settala's museum

the engraver has created the illusion that some of Settala's largest marine monsters have come to life, aiding the *putti* in their unveiling of these rooms. They eagerly await us as much as we await them.

What immediately strikes us about the depiction of Settala's museum is the variety of things portrayed as well as the self-consciousness about the spaces that house them. By the mid-seventeenth century the preferred format of the museum was no longer the study—one self-contained room—but the *gallery* which a contemporary dictionary defined as a "place to pass through."[16] There is no room to contemplate in the gallery because one is not supposed to stop. Movement rather than stasis, publicity rather than intimacy, knowledge on display rather than knowledge in pursuit of wisdom, defines it. The gallery reflects several centuries of refinement in the cultivation of objects. Its contents are more global, as the Tupinamba ceremonial cape prominently displayed in the right gallery [Fig.3] and the Chinese vases in the lower left suggest, and also more crafted: perpetual motion machines, clocks, paintings, trophies of war jostle the ancient statues that evoke Greece and Rome. Even the walls are no longer simple, for one can see hints of a brocaded fabric behind objects in the side galleries. Nature and art, pagan and Christian, local and foreign artifacts define this Baroque cabinet of curiosities.

What if the Crocodile Could Speak?

In contrast to the undifferentiated terrain of Petrarch's study, Settala's gallery creates a world of special boxes and special niches. Everything in its own place and never in someone else's. Perhaps the most distinctive impression emerging from prolonged viewing of the engraving of Settala's museum is the infinity of boxes that unfolds before us. Reaching far into the unseen depths of the gallery—conveying the illusion that one may never reach its end (a sensation visitors to the Louvre have surely experienced)—the boxes entice us at first with their specificity. We peer closely to admire the workmanship of each box, for the engraver has hinted at enough of the detail that we can imagine their beauty. Further into the gallery, this vision recedes and the cabinets, the *kunstschrank* which delighted Europeans, become generic, worthy of enumeration more than admiration. In the end, we accept the view of the crocodile that, perched precariously at the front of the gallery, looks away from the objects as if to tell us that it does not matter whether or not we see these things: we simply need to acknowledge that they are there. [Fig.4]

One Does Not Spit in the Museum

In his *Remembrances* (1563), Sabba da Castiglione tells the story of Diogenes who, finding himself in the house of a gentleman, spit in his face because it was the "least ornate and least beautiful place" in his home.[17] By contrast, the museum increasingly competed with such settings as the family chapel to become the most aestheticized part of the home—a place where crude bodily functions could not be performed. We might take this as yet another definition of the museum; it was a civilizing tool that tamed the upper classes by compelling them to admire certain objects and to see their ability to discern quality and rarity — in short, to comprehend *value*—as one of their most important distinguishing features.[18]

In becoming a tool through which taste was affirmed, the museum ultimately began the process of separation from the homes of European elites that eventually led to the creation of the Museum, a structurally autonomous institution. Yet this was a process, to borrow Benedict Anderson's phrase, that first had to be *imagined before it could be realized*.[19] Settala's gallery in mid-seventeenth century Milan is one example of the prolonged fantasy of the museum that has made it such an enduring cultural institution. If we do not spit in museums today, it is partly because we have internalized the values made explicit by early modern elites when they first began to envision culture as worthy of containment. Such behavior was practiced initially within a special part of the home, subsequently within other people's homes, and ultimately in a location where no one lived anymore.[20]

Breaking the Container

By Settala's day, patricians had become used to the presence of strangers in their home. The ebb and flow of courtiers and scholars, bearing letters of introduction and other means of assuring their reputation, defined the museum as long as it remained within the family palace, creating a lively social arena in which great ambitions could be advanced. Surely one could ask the favor of a cardinal when he lusted openly for a stick of cinnamon, the latest Etruscan tablet, or the ubiquitous armadillo?

Yet increasingly as museums passed from one generation to another, afficianados began to notice a disturbing trend: long in formation, museums were quick to disappear. Often the personal vision of a single family member, the museum was an insecure patrimony. Heirs frequently sold as many objects as they could upon the death of a collector, to the delight of those who preyed upon such auctions and to the despair of scholars who felt that the value of the museum lay in its potential to be a permanent house of knowledge. Situated somewhere between the private affairs of a noble family and the ill-defined realm of culture, the museum occupied ambiguous territory indeed.

Let me offer one example of how these concerns were articulated. From 1603 until 1630, the Academy of the Lynxes (*Accademia de' Lincei*) created a network of intellectuals interested in the new scientific learning stretching outward from Rome, its original center, south to Naples and north to Germany. Founded by a young and rebellious Roman prince, Federico Cesi, and his companions, the academy saw itself as the centerpiece of an intellectual revolution. After a somewhat rocky start, Cesi began to attract distinguished scholars to his academy, among them, the Florentine mathematician Galileo Galilei and the Neapolitan magus Giovan Battista della Porta.

Museums were a central organizing feature of the academy; both Cesi's museum in Rome and Della Porta's one in Naples became congregating points for regional members. Cesi ultimately imagined them to be the locations in which the various Lincean "colonies" would be housed. As Della Porta aged, the younger Linceans began to worry about the fate of their colony

in Naples if they did not secure his museum.

By the 1610s he was in his seventies—it was only a matter of time. In 1612 they received a verbal promise from Della Porta that he would "donate his entire library and study" to create the Lincean colony in Naples. However, to their consternation, Della Porta refused to put any of this in writing. The following year, the other Linceans began a campaign to persuade Della Porta to officialize the donation. In a 1613 letter to Francesco Stelluti, Cesi outlined the reasons why Della Porta should pursue this goal. First, it would allow them to maintain his fame through the continued visits of foreigners to his collection. Cesi suggested that Stelluti remind Della Porta of the generous gift made by Fulvio Orsini to the Vatican Library upon his retirement as its librarian and of the unfortunate dissipation of Pietro Bembo's library because he had not made any provisions. Such examples were designed to remind Della Porta that memory was a very fragile thing indeed, something only preserved with foresight. Finally, Cesi argued that Della Porta's heirs would be unable to appreciate his museum: "it would be thrown away, *it would be of little use in the home*, either because it would not be used or because it would be sold and dispersed . . ."[21] Such an attitude finds a remarkable parallel in the circumstances of the *Studio Aldrovandi* in seventeenth-century Bologna, whose custodians encouraged leading notables to donate their best objects to the museum in the Palazzo Pubblico so that "what often in private homes is either lost or treated badly may be preserved."[22]

Despite the pleas of Cesi that Della Porta consider his museum to be a larger form of cultural patrimony, when Della Porta died in 1615 nothing had been finalized and the museum soon disappeared. Cesi himself did not heed his own advice. When he died unexpectedly in 1630, he had made no provisions for his academy; some papers fell in the hands of the Linceans but the museum also went the way of Della Porta's and, shortly thereafter, the academy itself dissolved. An academy without its prince was surely precarious. But an academy without its museum was simply ephemeral.

In the course of evolving his plan for a scientific academy, Cesi had realized the importance of museums in housing the knowledge accumulated by scholars during and beyond their lifetimes. And he had increasingly acknowledged the difficulties of keeping that knowledge in the home.

The Collectors Have Their Say

Would collectors themselves have understood the process I have been describing? As a thought experiment, let us see what Petrarch might have said to Settala if he had had the chance:

Petrarch. What has happened to my study? I can hardly think in here!

Settala. Thinking is done elsewhere, this is my museum. Come admire it. My perpetual motion machines are the best in Europe. Here you can drink chocolate from the tusk of an elephant. Or would you like to see the five hundred and one examples of agate that I've placed in the cabinet below the Caravaggio? Two German friars traveling through Milan on their way back from China gave me this lovely porcelain .

Petrarch. Stop! How can you drone on like that, without even taking a breath? Does any of it really matter to you?

Settala. Matter?!? Do you know how many Medici princes have visited my gallery? Would you like to see the visitor's book? Here I have the signatures of all the best men in Europe[23] Their gifts are strewn throughout my collection.

Petrarch. You talk of quantity, and I speak of quality. How can all the things in the world compare with one good thought. If you'll just read this letter from Cicero which I found only last week in Verona . . .

Settala (impatiently). I've seen that letter. It's right next to your signature in a collection I saw in Bologna last year, just beneath a bust of Dante. In fact, you'll be happy to know that the value of your signature is fast approaching the value of Cicero's.

Petrarch. Value? I'm not sure I understand.

Settala. People like to possess you, Petrarch. You've become part of our historic patrimony. Of course I prefer to collect Galilean artifacts because I anticipate that one day people will praise me for my foresight in this matter, even if it's currently unfashionable among my fellow clerics to care too much for our heretical astronomer.

Petrarch. This is not at all the future I envisioned. Didn't you read Augustine? Haven't you understood that excessive knowledge blinds us to true wisdom, which lies within us and not in things?

Settala. Of course I've read Augustine. Who hasn't? (Gesticulates upward). I think I've got his portrait over here. But, really, why all the fuss? If I want to be contemplative, I can just exit the museum and enter my study. Can't we do both in this world?

Petrarch. Personally I found it impossible. If you had read anything other than my signature, you would know that I despaired at man's worldly quest for knowledge. "And what good is it to know a multitude of things? Suppose you have learned all the circuits of the heavens and the earth, and the spaces of the sea, the courses of the stars, the virtues of herbs and stones, the secrets of nature, and then be ignorant of yourself?"[24] You are too confident of your abilities, Settala.

Settala. Perhaps. But shouldn't I take pride in creating one of the best collections in Europe? People come from all over to see my things.

Petrarch. And that is exactly the problem, isn't it? When do you have time for the study? If I could invite Augustine to join us, he would banish your visitors and your objects and leave us in peace.

Settala. But who could think when the walls are bare?

Undoubtedly I have made Petrarch too idealistic and Settala too cynical, since surely they would have found some common meeting ground if they had talked long enough. In the end, however, I am not sure that they would have found much to share in the museum, other than a love of the past and a passion for discovering knowledge.

Dormant Objects

As I have suggested throughout this essay, the period between the fourteenth and seventeenth centuries was a particularly crucial one for the development of museums. New curiosity about things, new ideas about the use and articulation of space within the home, and new sensibilities about the visualization of cultures gradually transformed the study into the museum. Most of the settings in which these early cabinets of curiosities arose have disappeared, undone by the constant reappropriation of space typical of a multigenerational family dwelling. Most of the objects have also vanished, for they were equally incapable of attaining the longevity that their possessors hoped they might have. Returning to Harbison's idea of the eccentric space, perhaps we might add a further attribute. As a mutable location, the museum is a particularly fragile institution for all its appearance of durability. Lest we be deceived by the alleged permanency of late twentieth-century museums, we need only ask ourselves how much of the museum resides on display and how much lies in storage—discarded trophies that almost no one ever sees. □

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Figure Sources

1. Wolfgang Liebenwein, *Studiolo. Storia e tipologia di uno spazio culturale*, ed. Claudia Cieri Via (Ferrara: Istituto di Studi Rinascimentali, 1988).
2. Paolo Maria Tergazo, *Museo o galleria adunata dal sapere, e dallo studio del sig[nor] Canonico Manfredo Settala nobile milanese*, trans. Pietro Francesco Scarabelli (Tortona, 1666).

Notes

1. Robert Harbison, *Eccentric Spaces* (Boston: David. R. Godine, 1988; originally published in 1977).
2. Ibid., p.147.
3. See Jean Baudrillard, "The System of Objects," in John Elsner and Roger Cardinal, eds., *The Cultures of Collecting* (Cambridge, MA: Harvard University Press, 1994. In addition to Hooper-Greenhill's historical view of museums, see Susan Pierce, *Museums, Objects and Collections: A Cultural Study* (Washington, D.C.: Smithsonian Institution Press, 1992).
4. Krzysztof Pomian, *Collectors and Curiosities: Paris and Venice, 1500-1800*, trans. Elizabeth Wiles-Portier (London: Polity Press, 1990), p.5.
5. See Pierre Bourdieu, *Distinction: A Social Critique of the Judgment of Taste*, trans. Richard Nice (Cambridge, MA: Harvard University Press, 1984).
6. I have discussed this subject in greater detail in Paula Findlen, *Possessing Nature: Museums, Collecting and Scientific Culture in Early Modern Italy* (Berkeley: University of California Press, 1994). While the fundamental study on collecting remains Julius von Schlosser, *Die Kunst- und Wunderkammern der Spätrenaissance* (Leipzig, 1908), a good starting point is Oliver Impey and Arthur MacGregor, eds., *The Origins of Museums: Cabinets of Curiosities in Sixteenth- and Seventeenth-Century Europe* (Oxford: Oxford University Press, 1985).
7. Roberto Weiss, *The Renaissance Discovery of Classical Antiquity* (Oxford: Basil Blackwell, 1988; originally published in 1968).
8. For a more detailed discussion of the idea of *musaeum*, see Findlen, "The Museum: Its Classical Etymology and Renaissance Genealogy," *Journal of the History of Collections* 1 (1989): 59-78.
9. On Petrarch's study, see Wolfgang Liebenwein, *Studiolo. Storia e tipologia di uno spazio culturale*, ed. Claudia Cieri Via (Ferrara: Istituto di Studi Rinascimentali, 1988; German edition published in 1977), pp.19-40.
10. *A Tour in France and Italy made by an English Gentleman, 1675*, in *A Collection of Voyages and Travels* (London, 1745), vol.1, p.419.
11. On a more local level, this argument has been advanced for Medicean Florence; see Edward L. Goldberg, *Patterns in Late Medici Art Patronage* (Princeton: Princeton University Press, 1983).
12. Joseph Addison, *Remarks on several Parts of Italy in the Years 1701, 1702, 1703* (Glasgow, 1755 ed.; originally published in London, 1705), sig.a.3r.
13. Maximilian Misson, *A New Voyage to Italy*, English trans. (London, 1695), vol.1, sig.a.3r-v.
14. There is very little written on Settala in English. For non-Italian readers, see Findlen, *Possessing Nature*, *passim*. Specialists may want to consult: Vincenzo de Michele, Luigi Cagnolaro, Antonio Aimi and Laura Laurencich Minelli, *Il museo di Manfredo Settala nella Milano del XVII secolo* (Milan: Museo Civico di Storia Naturale, 1983).
15. Paolo Maria Terzago, *Museo o galleria adunata dal sapere, e dallo studio del sig[nor] Canonico Manfredo Settala nobile milanese*, trans. Pietro Francesco Scarabelli (Tortona, 1666).
16. See the entry for "galleria" in the Accademia della Crusca's *Vocabolario*.
17. Sabba da Castiglione, *Ricordi* (1563), cc.118v-119r, in Gigliola Fragnito, *In museo e in villa. Saggi sul Rinascimento perduto* (Venice: Arsenale, 1988), p.203n13.
18. Here I am following the argument sketched out by Norbert Elias, *The Civilizing Process*. Vol.1: *The History of Manners*, and Vol.2: *Power and Civility*, trans. Edmund Jephcott (New York: Pantheon, 1978). This point has also been raised in a discussion of the Cospi museum of Bologna, by Jay Tribby, "Body/Building: Living the Museum Life in Early Modern Europe," *Rhetorica* 10 (1992): 139-163.
19. Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism*, rev. ed. (London: Verso, 1991).
20. Describing the fake aura of domesticity that infused many Victorian museums, Robert Harbison observes: "Rooms like these suggested that the family had left them only the moment before, present-day museums barer first of all so we will not make the mistake of thinking anyone lives there." In his *Eccentric Spaces*, p.149.
21. Cesi to Galileo, 17 March 1616, and Cesi to Stelluti, spring 1613; see Giorgio Fulco, "Per il `museo' dei fratelli Della Porta," in *In Rinascimento meridionale. Raccolta di studi pubblicata in onore di mario Santoro* (Naples: Società editrice napoletana, 1986), pp.6-8. Emphasis mine.
22. Biblioteca Comunale dell'Archiginnasio, Bologna, ms.1346 (quote is from title of the book of donations). The transformation of the *Studio Aldrovandi*, initially the private museum of the naturalist Ulisse Aldrovandi who donated his collection to the Senate of Bologna in 1603, is discussed in Cristiana Scappini and Maria Pia Torricelli, *Lo Studio Aldrovandi in Palazzo Pubblico (1617-1742)*, ed. Sandra Tugnoli Pattaro (Bologna: CLUEB, 1993).
23. In his *Orazione funebre* (1686), Giambattista Pastorini described a *libricciuolo* (little book) that "indicated the rare names of his many correspondents and friends throughout the world." In Gino Fogalari, "Il Museo Settala contributo per la storia della cultura in Milano nel secolo XVII," *Archivio storico lombardo* XIV, 27 (1900): 91.
24. This is a paraphrase of Augustine, *Confessions* X. 8. 15. Petrarch frequently invoked this image in such writings as *The Ascent of Mont Ventoux* (1336) and *On His Own Ignorance and that of Many Others* (1368). Both texts are reproduced in Ernst Cassirer, Paul Kristeller, and John Herman Randall, Jr., eds., *The Renaissance Philosophy of Man* (Chicago: University of Chicago Press, 1948), pp. 36–134.

Virtual Interview of Peter Galison, May 1995

(Virtual?: Apparently Professor Galison responds via E-Mail and FAX to a number of written questions posed by the editor on the relationship between architecture and science. Galison is currently preparing a companion volume to the conference "The Architecture of Science" for MIT Press).

As the very title of your recent conference "The Architecture of Science" (Harvard University, May 1994) makes clear, metaphor and analogy have played an important role in mediating the relationship between the two cultures of architecture and science. Historically, terms such as organicism, mechanism, classification, and evolution have been exploited in various contexts as both constitutive and regulative frameworks. More recently, themes from molecular biology, epidemiology, high-energy physics, and especially artificial intelligence have gained currency. What is the future of metaphor and analogy in structuring this relationship.

One of the themes that emerged from "The Architecture of Science" conference was the deep concern that architects, architectural historians, architectural theorists, shared about the scientization of architecture. In very different ways, both Kenneth Frampton and Denise Scott Brown see—in the last forty years—wave after wave of attempts to make architecture into a science. Both Frampton and Scott believe that all these tidal surges—from Bauhaus to computer design—crashed at the door, doing more or less damage as they encountered the irreducibly craft nature of the discipline. Interestingly, both Alberto-Pérez Gomez and Adrian Forty emphasized that science and architecture were once (into the Renaissance) not even distinct endeavors. Working with that understanding, Forty rather intriguingly points out that mechanistic and biologistic metaphors could not function in architecture until the separation had taken place. So, far example, biological circulation was available in some sense since the work of William Harvey—but it was several hundred years before such images became part of architectural reasoning, and an ideal of the building professions. That it was chosen and remains central must furthermore (Forty argues) be attributed to certain ideological commitments: circulation emphasizes self-containment and independence from the outside: other metaphors (such as breathing) emphasize the interaction with the environment. I would emphasize that such metaphors carry enormous power—choosing self-containment over interaction brings certain considerations forward (self-regulation, aesthetic isolation) and others at the periphery (access, links with the wider environment).

How the new range of metaphors will function depends to a large extent on which features of these fields comes to be salient. Take artificial intelligence. If the focus narrows to the central cybernetic notion of self-regulation, the concept of architectural individualism (autonomy of building from their outside world) may continue unchallenged and as such simply further articulate the notion of circulation that has marked modernism from the early twentieth century. Artificial intelligence is, however, a tremendously powerful complex structure from which metaphors may be drawn. Focusing on notions of flexible problem solution, for example, the de-specification of a single form-function association, might well provide an opening to different ways of thinking about space, one more accommodation to the shifting shape of science (and other aspects of our contemporary culture). So I would say this: as such the metaphorical fields of molecular biology, epidemiology, high-energy physics, and artificial intelligence to not vouchsafe a shift from mechanical reductionism of pumps, tubes, circulation, and static-force equilibrium.

Sociologists of science have emphasized the role of architecture in creating credible witnesses of scientific endeavor, and by extension producing a public for science. A parallel claim is made that the social distinctions and competing interests written into the organization of space is reinscribed in the constitution of this public, be it actual or virtual. What do you see as the role of "places of knowledge production."

In your own work with Caroline Jones you have identified the "laboratory," "studio," and "factory" as sites of scientific and cultural production. Their affiliation raises specific questions regarding the shared experimental tradition of the artistic avant-garde and high-energy physics. The genealogy of the avant-garde and of experimental science has often been described in terms of the dynamic opposition between normal and critical practices, routine and alternative spaces. How can models such as "dispersion" be used to understand the by-definition self-transformative "place of experiment."

One of the most interesting developments in recent history of science has been the attention paid to the locality of knowledge, and to the sites of knowledge production. This attention to context, to scientific work not as a "view from nowhere" but rather as knowledge that emerges within the constraints of time and place, using the resources available then and there. We now have work (by Crosbie Smith and Norton Wise, *Energy and Empire*) showing precisely how Lord Kelvin's electrodynamics participated in the industrial culture of industrial England—how his theories of electricity were part and parcel of the specific needs and constraints of laying underwater telegraph cables, for example. We have studies of 17th century science that show how Boyle's notion of witnessing, repeatable, phenomenological experimentation was part of a post-Restoration view of how disputes could be resolved whether in politics or natural philosophy (Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump*, Princeton, 1985). My own earlier work took up a variety of such themes, for example in showing how Einstein's theory of magnetism and atomic structure emerged in part from his patent work on gyroscopes in the mid-1910s (in my *How Experiments End*, Chicago, 1987).

Place—the specific, local site—played an essential role in recent consideration of how science has evolved. In my recent work, I have been exploring very recent and very large-scale experimentation—experimentation on the scale of billions of dollars, such as that planned for the (now-defunct) Superconducting Supercollider. In these projects, the concept of "place" becomes ever more poorly defined. Particles collide in one place, data are then "generated" in a long sequence of computer-aided modifications over many different sites. These data are then fed out over the computer nets to tens, sometimes hundreds of institutions. In one SSC experiment there were to have been a thousand PhD physicists spread out over several continents. Even the control room of the accelerator was to have been multiplied many times, one in Japan, several in the United States, one in Europe, and perhaps even more. Consequently, I have argued, it becomes impossible to say "where" the "experiment" is—what does a "local" study of scientific production mean in such circumstances? (*Image and Logic: The Material Culture of Modern Physics*, forthcoming).

Carolyn Jones has similarly explored many attempts to remove a fixed conception of art (or more explicitly, modern art) from the studio (*Machine in the Studio*, forthcoming, Chicago). In a joint essay for the *Architecture of Science* volume, Jones and I proceed in three steps. First, we address the ideology of a genial artistic and scientific creator—the lone artist or experimenter whose public solitude (so to speak) is deemed necessary for the work of art or science to emerge. In art this conception of artistic creation had a recent heyday in the abstract expressionists' studio; in the laboratory, the late nineteenth century could still make room for the Romantic scientist—Roentgen's self-imposed secrecy and isolation was legendary. Second, World War II, we analyze the factory both as a model for and a reflection of the new mission-directed laboratory-factory (such as Los Alamos); to many artists—perhaps Andy Warhol foremost among them—the daylight factory alternately in play and in seriousness became a better, more "contemporary" mode of production than the garret. Finally, after the 1960s, new conceptions of production began to break away from the centered and centralized structures of factory, laboratory, and studio. Experimentation—through simulation and computer data-transfer began to dis-place itself, challenging the identity experimenter-laboratory-experiment; artists like Robert Smithson self-consciously violated the co-production of artist-studio-artwork. In such circumstances place, locality, and context begin to lose their analytic force.

No we come up to my present work. For these recent studies (of the SSC, for example) indicate that context—an enveloping and explanatory "surround"—is not a transtemporally useful category. Let me put it differently. I am an advisory editor of a journal I like very much called *Science in Context*. The name itself suggests a picture of science modeled like a thought experiment from classical thermodynamics: a small vessel (science) coming to equilibrium in a much larger heat bath (social context). But is this picture useful in which the science is no longer "small" compared with whatever it is that purportedly surround its? What conceivable *exterior* could be posited as the context of the computer in the twilight years of this century? When Moshe Safdie begins to use the SSC as a model for urban design which way does the explanatory causal arrow go? Looked at this way, context is not a universal explanation of science, but a historically-specific configuration of science and society in a particular epoch, say from the mid-16th century to the mid-20th century.

This is, then, one the quasi-paradoxical conclusions of *Image and Logic*: by tracking the context of the laboratory we come, in the end, to a dismantling of the historiographic category of contextualization itself. □

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David Mindell

Shipwrecks of Memory

Excavating the Guadalcanal

In the summer of 1992 I participated in an expedition to survey and photograph Japanese and American warships that sank during the devastating battle of Guadalcanal, in 1942. The project was sponsored by the U.S. Navy and National Geographic. Using modern submarines to discover sunken naval vessels of a half-century ago overlaid modern and historical technology; the machines of today observed the failed machines of the past in the strange and alien world of the deep ocean. Travel to the ocean's depths produces its own metaphoric associations, and as such it provides a unique way of remembering modern industrial and technological warfare and the terrain over which it sought mastery. A techno-mythical narrative may be a necessary means to explore a past that is itself increasingly techno-mythical.

Our seaboard home and command station during the expedition was the *Laney Chouest*, a 350 foot civilian research vessel on long-term charter to the Navy. Two submersibles were deployed from the ship to explore the wrecks, the *Sea Cliff*, a forty-foot submarine which can carry a pilot and two observers to a depth of 20,000 feet for about twelve hours, and the *Scorpio*, an unmanned robotic submarine or ROV (Remotely Operated Vehicle). *Scorpio* was connected by a cable to the *Laney Chouest* where a pilot and support crew controled its movement based on images sent up its tether from video cameras mounted on the vehicle. Our operations initially aimed to locate each of the wrecks laying in the depths of so-named Iron Bottom Sound, the site of the sea-battle. A preliminary expedition undertaken the previous fall had surveyed the area with sonar (SOund NAvigation Ranging, like underwater radar), producing maps which indicated dark shadows or "targets" at specific locations. The shadows contained enough detail to indicate the rough size, shape, and outline of a sunken ship but not enough to positively determine its identity. The goal of the mission was to visit each target with the ROV, positively identify the ships, assess their condition, and record their appearance. The process of identification, however, relied on more than the evidence of the video screens in the ROV's control room aboard the *Laney Chouest*. Data collected from a variety of historical sources helped produce hypotheses about the identity of each target which were then tested by visual cues as the physical wreck painstakingly came into view.

Staging the Battle

The island of Guadalcanal is over a hundred miles long and thirty miles wide, but only a small portion of it, toward the northeast corner, was disputed terrain during the World War II. Like many islands in the South Pacific, Guadalcanal was volcanicly formed, its only exceptional feature a small shelf, a few miles wide, between the mountains and the ocean. In 1942 this shelf represented the only suitable topography for a major airfield in this part of the South Pacific.

On August 7, 1942, an amphibious division of U.S. Marines landed on Guadalcanal and captured its airport from the Japanese, renaming it Henderson Field in honor of a fallen Marine. The Japanese had been slow to realize the airport's strategic importance and the Marines faced only light resistance from the small Japanese construction battalion which was still completing the runway. For the first few days after the August 7 landing, American transports unloaded supplies and equipment for the Marines to hold the airport. The Japanese had been taken by surprise by the invasion; as time went on they became ever more determined to recapture the airfield from the still small American force. As each side attempted to resupply and to protect their isolated troops fighting for control of Henderson Field, the area around Guadalcanal was the site of the most concentrated series of naval battles in history. Formerly known as Indispensable Strait, the waterway was renamed Iron Bottom Sound after nearly forty warships sank there in 1942 and early 1943.

The two forces had prepared to fight the war in different ways, largely because of the different technologies they possessed and the manner in which they were employed. As a result of interwar treaty limitations, the Japanese had fewer ships than the Americans. To make up for this weakness the Japanese trained specially in night-fighting at sea. The Allies, with more and larger ships, worked from a different doctrine, emphasizing long-range engagements in daylight, so they were unprepared for battle in darkness. Shortly after 1 AM on August 9, a Japanese flotilla of seven cruisers and one destroyer entered Iron Bottom Sound from the Northwest, using Savo Island and its cloud cover to hide from the Allied patrol. Savo Island, actually a small valcono, protrudes steeply up two thousand feet straight out of the ocean. The cone looms as an ominous presence over Iron Bottom Sound. The Japanese force remained undetected until they rounded the island, achieving nearly complete surprise of the Allied force. Their blindness was partly due to their dependence on technology, relying on innovations which were not completely effective when they were new. Historian Richard Frank writes:

> Ships of the [Japanese] Imperial Navy detected their opponents by visual means before radar discovered their presence. The primitive radar in use at this time suffered drastic reduction of already limited detection ranges because of echoes from landmasses, a phenomenon not well understood by Allied commanders, who were apt to repose excessive confidence in their electronic eyes.[1]

The Japanese improved existing methods, concentrating on their strength in optics and training. "By contrast, the Japanese sought and achieved maximum performance from optics by utilizing specially selected lookouts equipped with outsized binoculars."[2] The Japanese came out of the night at high speed, decimated the Allied ships, and disappeared around Savo Island heading North as quickly as they had appeared.

Occupying less than two hours from beginning to end, The Battle of Savo Island was the worst defeat for the U.S. Navy since Pearl Harbor, nearly a year before. The Allies lost seven ships, including four cruisers, with a total of 1077 men killed. Fortunately, the Japanese did not decide to pursue the vulnerable transports still unloading their gear. The next morning, however, Marines on Guadalcanal, with less than twenty percent of their supplies unloaded, watched as the transports, deprived of protection, withdrew with the remainder of the equipment. The defeat at Savo Island left the Marines stranded and unequipped to defend the island airbase that the Japanese desperately wanted back.

Astoria Found and Lost

Now, nearly fifty years later to the day, our expedition is heading to a wreck that we think will be the *Astoria*, an American heavy cruiser that sank at Savo Island. *Astoria*'s crew had been caught unaware and unprepared, and wasted several crucial minutes in the confusion of night battle at sea. Its airplane hangar had been set afire by a shell, and the flame invited shots from four enemy ships. *Astoria* was abandoned and sank at about noon on August 9. Our shipboard naval historian connects the circumstances of the *Astoria*'s sinking with the current target. It is 4:30 AM as the *Laney Chouest* heads toward the estimated target location.

We are working in the *Scorpio* "control van," a trailer-sized shipping container welded to the aft deck of the *Laney Chouest*. Racks of video monitors, sonar equipment, and plotting stations crowd a windowless, air-conditioned laboratory. A team of four navy petty officers operate the vehicle; the pilot "flies" *Scorpio* with a joystick and controls its engineering systems; a sonar operator tracks the bottom and scans ahead for approaching objects, a critical function as the visibility through the video cameras is usually less than twenty feet; a navigator tracks the location of the vehicle in three dimensions using a separate sonar system, and keeps in constant touch with the bridge to direct ship movements; a navy watch leader directs the entire operation, taking direction from the historian and commanding and coordinating the other three operators. All concentrate on a set of video monitors presenting images from the cameras on the *Scorpio*, nearly a half mile below.

The historian has collected information on the ships which we expect to find, including drawings, photographs, battle reports, and various reported positions of sinking. The geographic importance of Savo Island is underscored by the fact that many sighted locations, from both sides, are given as a range and bearing from the volcano. Once a wreck is found the historian directs *Scorpio*'s crew toward those features which will yield positive identification. Sometimes the definitive clue is provided by the ship's architecture and armanents, such as

the number of gun turrets, or the shape of a smokestack. Some of these ships were of the same design, however, and in these cases the distinguishing features are more subtle, such as a particular radio beacon or a gun added to one ship and not another. Ship recognition is not a modern science, and the task we are performing parallels that of the lookouts themselves on the night of the battle, trying to asses enemy forces, determining friend from foe at long distances with poor visibility. It is an act of reading, taking incomplete clues from imperfect sources and drawing a conclusion, assigning a name to a thing.

It has been four hours of transit from a previous wreck site. We review the historical data and what we expect to see. The historian pastes a drawing of *Astoria* on the wall. A New Orleans Class heavy cruiser, *Astoria* was 580 feet long and displaced just under 10,000 tons. Its main armaments were three turrets of three eight-inch guns each, two forward and one aft. Just behind the bridge were two catapults for launching float planes and a hanger for storing the aircraft. The bridge has a sleek, almost Art Deco look, and its heavy armor gives it the appearance of a blockhouse rising above the deck. *Astoria* sustained a large number of hits before it sank, and is probably not in particularly good condition. There should be an exit hole from a torpedo hit under the forward capstan. The five-inch gun on the stern should be aimed aft and to port. A major shell hit was reported in the bow turret.

The ROV's sonar sends out an acoustic pulse, and its echoes, if they bounce off a target, return and sound through a loudspeaker and display on a screen with a rotating beam that looks very much like a radar set. (The terminology of the sonar "target" is by no coincidence the same as that used for aiming a gun; the technology we are using to explore these wrecks is a distant but direct descendent of that aboard the sunken warships themselves.) With no target, you hear mostly crackling noise, from small objects and rocks or electrical noise in the tether cable. These sounds, as they bounce around and echo, give one a feeling for the vast empty space below the surface, rather like a huge dark gymnasium. Now we hear a smooth, continuous tone. We have found our target, and it sounds as though the steel hull of a ship were itself reverberating. The tone increases in pitch as we approach. The sonar screen displays a large, distinctly ship-like shape. "Very large contact, dead ahead!" calls out the sonar operator. We are thirty yards away.

Now *Scorpio* begins to close in on the wreck. The sonar tracks the vehicle at forty feet, then thirty, then twenty. Still nothing in the video camera. Finally, at a range of ten feet,

a shape emerges out of the darkness. Its straight lines reveal it to be man-made, not sea floor or rock formation. The object is clearly large enough to be a ship, but what part of a ship? Which way does it lie? Are we looking at the side or the bottom? We cannot assume it lies upright, though most ships below a certain depth tend to right themselves on the way down. We find the corner of the deck; this wreck does indeed lie upright. We are most likely looking at the hull, and in the past few days we have developed some skill at orienting ourselves. First we rise, following up the hull until we see the corner of the deck. Then we travel along the edge one way or the other until reaching either the bow or the stern. Trouble is, many of these ships do not have a bow or a stern anymore, their hulls having been shot away or broken when they hit bottom. Worse, a hull bent at a right angle presents a danger, because the ROV's video camera has a very limited viewing angle. While traveling sideways fore and along the beam of the ship, we could find ourselves entangled from the side in unseen debris.

The historian shows the pilot a photograph of the *Astoria*, pointing out the features along the deckline we would expect to see. Toward the stern a big slab of steel should rise flush with the deck, the hangar for storing the cruiser's airplanes. We see a shape that could be an anchor, suggesting we are at the bow. But gradually, an undercut takes shape in the hull below the deck: *Scorpio* is approaching the stern. This slope becomes more pronounced, until we can say with certainty we are at the stern. The historian remarks, "I've got a sinking feeling that this wreck is not as big as we think and that it is a Japanese destroyer. This is simply not a cruiser stern." The sonar image of this wreck taken last year made it appear 450 feet long, definitely cruiser size. But, as we have found during the previous week, sonar measurements can be misleading, affected by everything from the speed of sound in water to the settings on the chart recorder.

The pilot brings *Scorpio* in closer, and we begin to see more details. A set of cables dangles just below the deckline. The historian recognizes them as degaussing cables, used to neutralize the ship's magnetic field to keep it from setting off mines. On American ships, however, degaussing cables were inside the hull, and these go around the outside, which was how the Japanese built them. Similarly, we notice gear for handling a paravane, a device dangled below and away from the hull of a ship to protect it from torpedoes. By the 1930s, only the Japanese were using this technology. We look closely one last time at the photograph of *Astoria*, the stern is large, with a marked shape different from what we are now seeing. This wreck is not *Astoria*.

We are a bit disappointed not to find what we expected. But now we have an unknown, and the challenge is fresh. We travel forward along the deck, especially observing the guns, a key distinguishing feature. A twin five inch gun mount on the main deck. Triple torpedo tubes. Smokestack. Another set of torpedo tubes. Bridge. Another pair of five inch guns. Moving back toward the stern, we see some writing on the hull. Moving in, it appears to be a single Japanese character painted in white. During the run forward and back, we have identified the heading of the wreck, which is pointing to 60 degrees, or southeast.

We notice a lot of structural damage to the deck and to the hull. Something large appears in the background. We rise up to take a closer look, and are startled to find a five inch gun barrel pointing directly into the camera, less than a foot away. The darkness inside the van, coupled with intense concentration on the images from the bottom, create a surreal feeling of being "down there" in the darkness with the wreck. Despite our rational knowledge that we are not physically there, the sight of the gun barrel is a bit frightening, and evokes the fierceness of these machines. We see another barrel parallel to the first one, an arrangement uniquely Japanese. The historian reviews his notes and believes this ship may be *Ayanami*, a destroyer sunk in a series of battleship actions several months after Savo Island. When hit by Allied gunfire, *Ayanami* was south of Savo Island, traveling east and shooting South. The guns on the wreck are pointed starboard, which is consistent with that story. Moving forward, an incredible amount of damage appears in the hull. The Japanese scuttled *Ayanami* after it was disabled, so this damage may be self-inflicted. We see holes in the side, plates sticking out, superstructure knocked over onto the deck. The major hull damage appears to be an exit hole from a torpedo which entered the other side at high speed. The bow has twisted off, and lies on its side in the sand, revealing the internal structure of the ship to *Scorpio*'s camera. Another historian, who reads Japanese, comes in the van. We move back to the stern and show him the Japanese character painted on it. It is the Japanese equivalent of "A." *Astoria* remains lost. We have found *Ayanami*.

Geography and History

Exploring the battles in Guadalcanal maps geography onto history, or perhaps history onto geography. In either case, the two were forcibly brought together by this event. We see this first in the name Guadalcanal itself. Originally, Guadalcanal was a place, but now it is the name of a battle, or a series of battles: a campaign. In twentieth century American history "Guadalcanal" is inextricably linked to the events of 1942. The word itself seems strangely evocative, as if the canal refers to a specific artifact, a feat of military engineering over which a battle was fought. In reality, the battle had nothing to do with a canal. The name Guadalcanal has its own colonial history, given to the site by the explorer Mendana in memory of his home town in Spain.[3]

The Battle of Savo Island also illustrates on a smaller scale the intermingling of geography and history through the naming of an event. One particular battle, that of August ninth, was named after the island, probably because it was the first to occur in this area, and also because the island itself played a critical role, hiding the Japanese attackers from the unsuspecting Allies. So the battle takes place on the island, and therefore inherits its name. As time passes, however, the process of representation reverses, and the ominous loom of the island comes to connote the disastrous memory of the battle, and even to stand for it as a kind of natural memorial. Maps of the Solomon Islands are replete with the names

of famous battles and skirmishes: Lunga Point, the Matanikau, Cape Esperance, Tassafronga, Tulagi. As Stewart Moredock, a survivor from the American cruiser *Atlanta* looks out over Iron Bottom Sound in 1992, he remembers battles as he sees geography:

> I could point to the battle of Cape Esperance that I was in, the Battle of Savo Island and the Battle of Guadalcanal, those three major Naval night battles, right before my eyes, I could picture them, all happening at night, just coal black night.[4]

For Moredock, events and places become inseparable. He could point to the battles when in reality he could point only to the location where they took place. This phenomenon is not unique to Guadalcanal: Bunker Hill, Gettysburg, Verdun, Khe Sanh. Few of us could claim to be familiar with these as places, yet we all know them as events.

The bottom of the ocean further complicates the idea of place and its representation by names in history. Indispensable Strait was renamed Iron Bottom Sound after the war, in memory of the ships resting there. But the bottom itself, where these ships actually lay, has no name. It has been, in effect, unspeakable, because, up until now, it has been unknown. Now, with our submarines and our cameras, we are in this place: we see it and bring it into being. It is the stage of our drama, the field of our work. And a field it is. Often during our expedition this place was referred to as a battlefield, or more precisely, an "underwater battlefield." This term exemplifies the overall complexity of representing Guadalcanal underwater. This space is not a battlefield: the battle was fought on the surface a mile or two above. But in sea battles the place does not record the event the same way it does for land battles. The battlefield of naval warfare is the ships themselves, where people experience combat.

The floor of Iron Bottom Sound is a surface projection of the "battlefield," the ships having undergone a transformation during the descent to their final resting place. Seeing this place, we seek to equate the site with the event, as we did with Savo Island. But Savo Island, though a living volcano, is a more fixed topographic reality, retaining physical qualities that link it directly to the battle as a landmark. Not only does the sea floor lack such qualities, but its own characteristics—the absolute darkness, the near-freezing cold, and the utter inaccessibility to all but complex machines—are not related to the events of the battle. When we explore the wrecks, however, the space of the bottom of the ocean feeds back on the memory of war, lending its dreamlike qualities to the events of the past. Individually or collectively, we cast the images of wrecks in deep water into the mold of the battle, and the physical qualities of the ocean floor become metaphors that help us imagine history. In this way, the deep sea becomes a dense fluid monument. □

Figure Sources

p. 14, collection of the author.
pp. 12, 16, Robert D. Ballard, *The Lost Ships of Guadalcanal* (New York: Warner/Madison 1993).

Notes

1. Richard Frank, *Guadalcanal: The Definitive Account of the Landmark Battle* (New York: Penguin Books, 1990), p. 103.
2. ibid., p. 103.
3. The ships themselves also reflect the importance of naming. Not a few of the allied vessels were named after places, often to represent the place from which they came.
4. Stewart Moredock, *National Geographic* Television interview (August, 1992).

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Conspicuous Skills

Technological Expertise and the Functionalist Aesthetic

Amy Slaton

Much of what we call "taste" lies in this, the conformity between discriminations demanded by a painting and the skills of discrimination possessed by the beholder.
Michael Baxandall, Painting and Experience in Fifteenth Century England[1]

For reasons that are not entirely clear, neither historians of architecture nor historians of technology have made it their task to consider how technological expertise has informed architectural taste in this century. We recognize that much of the civic and commercial architecture around us has some basis, however dilute, in the modernist program of "truth to materials," and see that this ideal conforms to economies inherent in mass-produced, unornamented building types. This conformity suggests a complex of connections between building design and the conditions of building production and trade. Yet, historians of technology who address building processes generally study the relationship of technology and architecture only from the perspective of how scientific and technological knowledge informs the design decisions of architects. In truth, the relationship is much more richly configured. The histories of materials and the development of technological expertise in building in this century dovetail with the creation of a functionalist architecture: the visual "discriminations" demanded by many twentieth century buildings arise from the technologies of their production.

Aberthaw Construction Company, Catalog, 1926

The significance of technological expertise in the creation and reception of modern building styles resides in the influence of non-architects on building trends; namely, the processes by which scientific experts and producers of materials create reputations for their services. The successes of these practitioners stand in high relief for historians in the thousands of utilitarian buildings added to the North American landscape since 1900, designed not by architects but by engineering and building firms employing new building procedures and products. These factory buildings, power houses, warehouses, and railroad signal towers did not emerge uninfluenced by contemporary trends in academic architecture, but their primary origins are in their designers' impulses toward standardization and mass production. Their history offers a site in which to probe the relationship of functionalist building forms to contemporary technological, professional, and market practices.

To begin this project, we can borrow Michael Baxandall's directive for regarding painting, in which he recommends a method of aligning the production history of visual objects with their public reception. It is not a complete analytic instrument, as I will explain, but it does have some very useful suggestions for imbuing objects we normally treat as opaque with social complexity.[2] The usual role of technology in the written history of the visual arts seems to be that of explicating technique, or virtuosity, in order to describe the execution of more or less illusionistic conventions (or, secondarily, for the purposes of attribution). Baxandall instead connects representational technologies to the heterogeneous social and intellectual contexts from which they emerge and in which they find appreciative audiences.

He recounts an interplay of technical skills, market conditions, and expressive conventions. He describes how the cost of pigments influenced what colors painters used for different subjects, but that such choices were also constrained by the religious significance of the subject matter. We see also how the choice of landscape or figures for a painting's background could be determined by the willingness of a patron to spend money (figures took more time to paint), but that a display of a painter's skill (more figures, less landscape) could have a prestige value for the commissioner that might offset cost. Finally, Baxandall demonstrates that the importance of mathematical skill and gauging of volumes in the daily commercial life of fifteenth century Italy (or among those Italians likely to see paintings) created a disposition on the part of viewers to recognize what the painter had done: create complex forms out of regular geometrical bodies, and analyze volumes and surfaces of compound bodies. It was for "conspicuous skills" that the painters were paid.[3]

Baxandall's approach might seem at first to be truncated in a way. Unlike poststructuralist criticism that addresses the mutability of aesthetic values, his does not theorize how social relations such as those manifest in production and trade situations come to be instantiated through taste. He doesn't address the possibility, or impossibility, of change in aesthetic

doctrine.[4] But in fact, Baxandall's analysis suggests the array of social experiences from which discrimination arises (for painter and audience), and therefore offers a model for describing the hybrid nature of professional success in the arts. He does not assign meaning[5] to images on the basis of their resemblance to forms rendered in other historic circumstances, but retains an active, strategy-based notion of how imagery comes to have meaning. Baxandall's picture of expertise-in-formation applies to architecture as well as painting and helps demonstrate that even in highly standardized aesthetic idioms, expert knowledge can work as a significant prestige factor.

To test the usefulness of this historical approach, we can consider the development of the reinforced-concrete factory building in America between 1900 and 1930. These were structures of tremendous uniformity. Almost universally without ornament or cladding, they bared their standardized reinforced-concrete frames to the world. Most had large expanses of mass-produced steel-sash windows between their concrete beams and columns. The fifteenth-century painters possessed a multi-sided expertise that included technical knowledge and an understanding of how that technical knowledge appeared to patrons. In a parallel way, experts in the behavior and use of reinforced concrete after 1900 created a reliable and sophisticated artifact—the concrete-frame factory building—that publicized the skills of its creators. The exposed-concrete frame was both the literal trace of scientific knowledge and an advertisement of that knowledge. The commercial success of the reinforced-concrete factory building came through experts' interweaving of technical problem-solving with strategic maneuvering in the competitive market systems.

Aberthaw Construction Company, Catalog, 1926

The emergence of the reinforced-concrete factory building began with the transformation of concrete from an expensive and unpredictable commodity into one that fit the practical and economic conditions of early twentieth-century construction. Materials experts were central figures in this effort, performing pedagogical and scientific tasks with the commercial market for concrete in mind. Materials scientists and engineers established university departments for concrete research, taught succeeding generations of experts in the discipline, and adapted their knowledge for application in the daily routines of concrete construction.

Working within the university engineering schools eager to give their students practical preparation for commercial employment, the scientist-engineers created curricula geared towards the demands of the industry. They established state-of-the-art facilities in which to teach materials testing, and also used these laboratories to perform investigations for local companies. In their teaching and performance of materials testing, the academics worked to establish a secure status for their discipline within the world of competitive technological services. The concrete experts needed, on the one hand, to overshadow the established reputations of artisan-based building methods such as masonry and carpentry. On the other end of the commercial spectrum, they faced the

growing appeal of inexpensive, prefabricated "systems" of pre-cast concrete building elements. The use of such systems by factory builders required little expert intervention, and threatened the ongoing employment of the highly paid specialists and their students.

To create a niche between these competitors, concrete testing experts defined a double identity for their competence in which techniques and scientific objectivity were paired with claims of intuition, discretion, and other almost immeasurable benefits of practical experience. In the classroom, this pairing involved balancing theory and practice, universal and particular knowledge, and regimented drill and less predictable experimentation. As consultants to industry, the materials experts claimed the same balance in their own talents, but further articulated their special standing in the commercial sector. They chose to charge for some of their services but not others, and to publicize some findings but not others. They disengaged at selected times from their professional status to function instead as "neutral" scientific investigators and thus reinforce their objectivity, in their own eyes and those of their industrial clients.

Through these efforts, materials experts successfully placed their services on the open market for applied technological expertise while simultaneously narrowing the criteria for professional status in order to safeguard their unique status in that market. A similar doubled initiative characterized the experts' production of regulations, specifications, and codes for reinforced-concrete construction after 1900. Materials experts worked within emerging professional associations such as the American Society for Testing Materials and the Portland Cement Association to issue recommendations for safe, reliable cement products and concrete construction. These recommendations were adopted by other organizations and by many American cities in official building codes. In these specifications, methods of field testing received far greater emphasis than did specific performance criteria for concrete. Their authors believed the manner in which a test was conducted, and the expertise of the person by whom it was conducted, to be better guarantees of the quality of a cement or concrete than the achievement of specific test results. Here, again, applications of science were associated not just with particular practices but with particular practitioners.

Such applications of scientific knowledge held a compound appeal for firms that built factories in the early twentieth century. They signaled economy and reliability but also facilitated the implementation of hierarchies of skill and opportunity that were rapidly becoming entrenched in American construction as Taylorist tenets of systematic management gained a following. In many productive industries of 1900, labor was being minutely divided and conceptual tasks removed from the "shop floor" to managerial spheres. Firms that specialized in building reinforced-concrete factories followed this trend, and found the occupational distinctions promoted by concrete experts to fit tidily within their socioeconomic programs.

These firms offered an integrated set of services that included plant siting, design, and erection. Their operators claimed a broad knowledge base and experience in these areas, associating the reinforced-concrete factory building with technical and managerial expertise that was both specialized and comprehensive. By contrast, on the construction site itself, the firms implemented the rationalization procedures of large-scale industrial production. The physical work of concrete construction was relegated by firm managers to a stratum of workers believed to have little expertise, or little need for it.

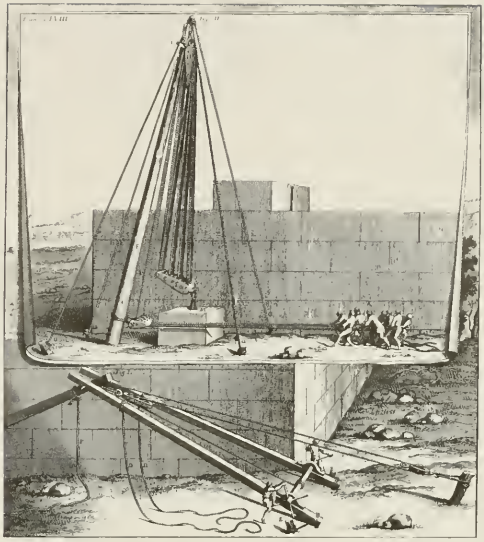
The separation of the two types of work was strictly maintained. This branch of the building industry mechanized many of the materials handling and assembly tasks that remained unmechanized in wood and masonry construction. By employing highly trained technicians to perform testing work on the site, concrete construction firms could further reduce the responsibilities of rank-and-file labor. With the new science-based and scientist-controlled testing procedures, factory-building firms enlisted a viable new technology while forwarding their managerial agendas.

For turn-of-the-century materials experts, the creation of a commercial jurisdiction following from the implementation of these work practices in addition to the concrete specialists' activities, have to be seen as at once programmatic and opportunistic.[6] The success of scientifically monitored reinforced-concrete buildings conferred a prestige on the engineers, and once made, reputations were used to bring further opportunities.[7] This control of opportunities within an occupational arena represents a particular social inequity–a consequence of the use of standardized building forms that is not explored in most accounts of twentieth-century architecture, even those that address the processes of commodification in the arts.

Kenneth Frampton, for example, describes restrictions on the contemporary practice of architecture that have arisen from universalization of technique, or "optimized technology." Concrete presents one such universalized building system, in his view. He advocates resistance to this homogenizing trend through an "interstitial" critical regionalism that would imbue design with cultural idiosyncrasy and particularity geared to the building site.[8] But from historical perspectives other than the timeline of high, canonical architecture, "optimized technology" does *not* represent a universal experience. To see it as such obscures the mechanisms of its endurance. The technology of standardized construction achieved its power by protecting the idea of a privileged, non-standardized sphere of production, from which differentiations about skill, and hence, opportunity would issue. By attaching to the university-trained tester a particular acumen, the academic experts associated tasks of materials testing with specific people, rather than with specific machines or methods. The proliferation of concrete technologies rested in engineers' promotion of their special skills and judgment; presumably some of the same "time honored craft practices" Frampton

claims are sadly missing from late twentieth-century architecture.

In other words, concrete may well be a technology based on "scientific, technological apolitical rationality" (here Frampton cites Ricoeur[9]), but rationality has local meaning. To cast the origins of this building technique beyond, or below, social-historical analysis is inappropriate. The engineers who dictated concrete use defined "personal equation" through which they posited amorphous negative qualities in the untrained, including unreliability and laziness–both arguably out of line with the rationalizing goals of business. But the other side of the equation ascribed mirror-images of those qualities to the engineers. The occupational standing and authority of the early twentieth -century materials experts facilitated the displacement of existing construction practices and encouraged the adoption of functionalist forms that celebrated that authority. The role of technological expertise in the emergence of the reinforced-concrete factory building and other utilitarian structures was self-conscious, complex, substantial, and now promises a rewarding site for the investigator of modern design.



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Notes

1. Michael Baxandall, *Painting and Experience in Fifteenth Century Italy* (Oxford: Oxford University Press, 1972, p. 34.
2. For a discussion of movements within the history of technology towards this type of analysis, see Hughie Mackay and Gareth Gillespie, "Extending the Social Shaping of Technology Approach: Ideology and Appropriation," *Social Studies of Science* 22 (1992), pp. 685-716.
3. Baxandall, pp. 1-27.
4. On the difference between "conventional" art historical and "poststructuralist" criticism, see Craig Owens, "Representation, Appropriation, and Power," *Art in America* 70 (May 1982), pp. 9-11. Owens describes the two disciplines as incompatible, art history believing "representation to be a disinterested and therefore politically neutral activity," and poststructuralist critique deeming representation to be "an inextricable part of social processes of domination and control."
5. This is along the lines of injunctions offered by Roger Chartier for the anthropological analysis of actions described in historic texts. In discussing ways to "decipher the symbolic system that underlies a text," Chartier warns that one must "define the instances of behavior and the rituals present in the text on the basis of remote resemblances to codified forms among the repertory of Western folk-culture. Roger Chartier, "Text, Symbol and Frenchness: Historical Uses of Symbolic Anthropology," *Journal of Modern History*, 1985; reprinted in *Cultural History: Between Practice and Representation*. Lydia G. Cochrane, trans. (Ithaca: Cornell University Press, 1988), p. 109.
6. My discussion of the relationship between scientific instruments and work distribution draws upon Robert E. Kohler, "Systems of production: Drosophila, Neurospora, and biochemical genetics," *Historical Studies in the Physical and Biological Sciences* 22 (1991), pp. 87-130.
7. On "reputation as process," see Howard Becker, *Art Worlds* (Berkeley: University of California Press, 1982), p. 352.
8. Kenneth Frampton, "Place-form and Cultural Identity," *Design after Modernism*, John Thackara, ed. (New York: Thames & Hudson,) 1988), pp. 51-57; see also Frampton's "Towards a Critical Regionalism: Six Points for an Architecture of Resistance," *The Anti-Aesthetic: Essays on Postmodern Culture*, Hal Foster, ed. (Port Townsend, Wash.: Bay Press, 1983), pp. 16-30.
9. Frampton, "Place-form and Cultural Identity," p. 56.

The following article is excerpted from the author's forthcoming book, *Path and Place in Modern Life, An Essay in Literary Geobiography.*

The Extraordinary Voyages of Jules Verne

mobile in mobilis

Rosalind Williams

Jules Verne grew up in a port from which sailing fleets had put to sea for centuries, creating a global net of trade. He spent his later years in a provincial city, creating a net of texts intended to "paint the entire earth, the entire world, under the form of the novel." Born in the age of sail, dying in the age of cinema, Verne links the origins of world alienation in the Renaissance with its twentieth-century destiny. He was obsessed with space, not as a means of knowing the world, but as a means of distancing himself from the world.

This paradox was first stated clearly by Michael Butor in his 1949 essay "Le Point suprême de l'âge d'or," usually considered to mark the beginning of modern Vernian criticism. Butor did not use the term "world alienation," but he showed how Verne's books, while supposedly describing geographic reality, push towards a place where reality disappears, where time and history are left behind in a timeless paradise.[1] From this basic paradox—global voyage as world alienation—arise the manifold contradictions and complexities of Verne's work that have so intrigued postwar generations of Verne scholars: high tech vehicles that resemble primitive caves, mechanized men who fall apart, wholly material nature that suddenly evaporates into nothingness, trajectories that go nowhere. Let us review these four themes (with a special attention to the first, supremely inventive decade of the *voyages extraordinaires*) to see how they relate to Verne's own spatial experience.

Verne's technological imagination is focused on vehicles, tools of progress that are also modes of regression. The most famous of them are the most technologically advanced: the actually existing *Great Easter*, the double balloon *Victoria* hovering over Africa in *Cinq Semaines*, the space capsule hurtling from the earth to the moon in the two moon novels, the *Albatross* and hybrid car-boat-plane *Eprouvante* of the two Robur novels, and most famous of all, the *Nautilus*, which combines cutting edge technology (one chapter of *Vingt mille lieues* is titled "Everything by Electricity") with the furnishings of the ideally furnished bourgeois salon.

These vehicles are much more than a setting in Verne's stories. They are themselves characters, and their engagements are leading elements of the plot (submarine vs. giant squid, balloon vs. arrows, steam elephant vs. bandits). Moreover, these are machines with souls, capable of acting heroically and of arousing strong emotional ties. The travelers to India weep at the "death" of the giant steam elephant, which heroically blows itself up to destroy the bandits; in *Cinq Semaines*, Ferguson thinks of the gas in his balloon as "his blood, his very life!" and mourns when his balloon "dies" by tumbling down a waterfall, after gallantly carrying its passengers to safety; and, of course, Captain Nemo proclaims of the *Nautilus*, "I love it like the flesh of my flesh."[2]

The technological sophistication of these vehicles, however, should not obscure their conservative, even regressive function. Tools of discovery, they are also shelters. "To travel in one's home, a rolling home, is probably the last word in progress when it comes to travel"[3] is the admiring comment on the giant steam elephant. In such inventions, Verne effaces the distinction between journey and dwelling. These vehicles are technological fixes that resolve the dilemma of the traveler who seeks not another place, but no place at all; who want to keep moving—*mobile in mobilis* is Nemo's motto—but who needs shelter to survive. Vehicle-shelters allow Verne's travelers to detach spatial movement from bodily awareness. They can move through space while enjoying the illusion of staying at home.

This paradoxical role of Vernian vehicles has been analyzed in another seminal essay, this one by Roland Barthes on the *Nautilus*:

> . . . the ship can well be the symbol of departure; it is, more profoundly, the figure of closure . . . the vessel is a fact of habitat before being a means of transport . . .[4]

Barthes proposes that the organizing principle of Verne's cosmology is that of confinement:

> The imagination of voyage in Verne corresponds to an exploration of closure, and the connection between Verne and childhood does not come from the banal mysticism of adventure, but on

the contrary from the common happiness of the finished [*du fini*], that one finds in the childish passion for cabins and tents: to shut oneself up and set oneself up [s'encore et s'installer], such is the existential dream of childhood and of Verne.[5]

The image of the boat, so fundamental in Verne's mythology, expresses not just spatial enclosure but also social control, implying "a whole nautical morality makes him at once the God, the master, and the proprietor (*seul maître à bord*, etc.)."[6] As Barthe's allusion to the proverbial phrase reminds us, Verne's lifelong fantasy was not just to go to sea, but to be captain of the ship. His imaginary voyages traverse the existing geographical world, but at the same time they involve the creation of a new social world. As the moon traveler Ardan (an anagram of the name of Nadar) exclaims to his fellows on board the projectile, "We inhabit a new world, the projectile peopled by us alone! Beyond us, outside us, humanity ends . . . "[7]

Now we can see how Verne's fantasy of shipboard liberation so readily flipped over to become the punishment of a prison. If we push Barthe's argument a little further, we see its sinister direction: the closed space of a clubhouse is not so different from that of a prison. Whether the ship is a tool of liberation or of confinement all depends on whether you are in command (Nemo) or under command (Professor Arronnax). The same Ardan who at the beginning of the moon journey calls the space projectile a "new world" says of it, towards the end of the journey, "It is a prison, but a traveling prison . . . "[8]

Verne's vehicles are not entirely enclosed however. Many of them have some sort of window, which permits the occupants to look at the world from a safe distance.[9] Some travelers look instrumentally (Barbicane and Ferguson with their sighting devices), others romantically (Ardan's vision of ruins on the moon, Joe's exaltation of aesthetic pleasure), and some do both (Nemo), but the common element is their reliance on vision. To travel, in Verne, means to look. The gaze of Verne's travelers is rarely the cut-up series of disconnected sensations typical of travelers in a railroad car. More often it is the coherent focus of someone watching a movie or videoscreen. So Ferguson gazed down at Africa from his balloon, Nemo gazes at the submarine world from the *Nautilus*, and the space travelers at the moon, all of them entranced by seeing what no one has seen before. In their passivity and distance from the external world, they are similar to the immobilized families of the nineteenth-century naturalistic drama who sit trapped in their living rooms, looking through the window to see what is happening in the world beyond, awaiting messages that come in from the world outside.[10]

While considerable attention has been devoted to Verne's vehicles, no less significant is the medium in which they travel. *Mobilis in mobile*: there is little liberty in having a mobile vehicle if it is confined to rigid, fixed pathway. Verne's travelers want the wide open spaces for endless voyaging. That is why the sea is so appealing to Verne: it is trackless. Many of the vehicles of the *voyages extraordinaires* are seagoing devices—one researcher has added up 259 vessels that play an active role in Verne's works[11]—and "The novels where one does not encounter a maritime of fluvial navigation can be counted on the fingers of one hand."[12] Even when water transport would not seem likely (as in the *Voyages au centre de la terre*) an episode is created (the storm on the sea of Lidenbrock). And even the loose constraints of traditional shipping lanes may be disregarded by Verne's supreme seagoing invention, the *Nautilus*, which can dive beneath the Suez Canal or break its own undersea pathway to the South Pole.

The air too is a mobile medium, and it too is the site of numerous Verne tales, whether set in the earthly atmosphere (balloons, Robur's aircraft) or beyond (voyages to the moon and comets). The land, however, is fundamentally different, non-liquid and non-liberatory. A traveler must either follow pathways already laid out by someone else, or risk being dragged down by the recalcitrant earth. In *Cinq semaines* the motto of Dr. Ferguson is "Excelsior!" and he and his fellow travelers repeatedly comment on the "perils and privations" they avoid by crossing Africa high above its surface.

Even the railway cannot overcome the fundamentally restrictive nature of land travel. In Verne's early works the railway is praised both as an emblem of progress and as a method of traversing great distances in a short time. But by confining the traveler to a pre-laid track, it annoys Verne's individualistic heroes. (Dr. Ferguson compares his determined character to a locomotive: "I do not follow my route . . . it is my route that follows me.")[13] Further more, the track might not be reliable: at a crucial moment in *Le Tour du monde* the railway track ends abruptly. As Verne grew older, his confidence in the railroad and enthusiasm for it steadily diminished.[14]

In sum, Verne's heroes want technological power detached from technological systems. Their motto could be (to borrow a famous line from Joseph Conrad's *Heart of Darkness*, muttered by Marlowe in a moment of dark illumination) "No system at all . . . " They are cyborgs, existing in atomistic isolation from other humans, merging themselves with their machines, which are as individualistic as they are, in order to conquer the cosmos. They become one with their vehicles. It provides them a portable home, while they give it a mission and direction. "Hatteras . . . was like the soul of this vessel, at one with it, like that of a man and a horse in a centaur."

[. . .]

The case of Verne, then, points to a salient feature of modernity: it is expansive enough to embrace its own defiance. In geographical terms, this expansiveness means that modernity provides space to evade modernity. Through the many technologies of mobile privatization, it allows people to enjoy the illusion of the open road, of getting away from it all. This is not all: modernity also provides space to construct alternative spaces, in which one may enjoy the illusion of going where no one has gone before. A vehicle is only one way of fulfilling the desire for mobile privatization, and in the computer age it is no longer the most im-

portant means. Computers can create an illusion of travel without being hooked up to an information highway. The ultimately fluid medium is cyberspace, and it is quite possible to travel through cyberspace without a highway.

The world space of Verne's extraordinary voyages is, like William Gibson's famous definition, "an infinite cage" in which bits and pieces of information are endlessly manipulated and recycled to create an alternative reality. The paradigmatic hero of Verne reminds us that the term *cybernetics* comes from the Greek word for the helmsman or pilot. The Vernian hero is a cybernaut who navigates through a universal medium of information bits, "explores scientific data by moving through their representations in a virtual world."[15] Movement through a virtual world is always accomplished by a mix of technological and aesthetic means. In terms of technology, Verne uses only language, but with that tool he pushed off from the physicality of earth to an enticing *milieu libre*. Instead of confining himself to an information highway, Verne sailed on an "information ocean."[16]

For a long time now, Verne has been hailed as a "precursor of modern scientific discoveries" (the text of the plaque that marks his birthplace in Nantes) and, even more commonly, as a forerunner of modern scientific fiction. Is he now to be hailed a forerunner or precursor of hyperreality? Certainly his visions of the material world becoming an empty void call to mind Jean Baudrillard's comments on hyperreality:

> Simulation is no longer that of a territory, a referential being or a substance. It is the generation by models of a real without origin or reality: a hyperreal . . . it is the map that engenders the territory . . . *The desert of the real itself.*[17]

Even more does Verne's life project of mapping the entire globe, fully and comprehensively, recall the famous postmodern map of Borges, in which geographic reality is replaced by a symbolic construction. Of the Borges parable, Baudrillard comments:

> If we were able to take as the finest allegory of simulation the Borges tale where the cartographers of the Empire draw up a map so detailed

that it ends up exactly covering the territory (but where, with the decline of the Empire this map becomes frayed and finally ruined, a few shreds still discernible in the deserts—the metaphysical beauty of this ruined abstraction, bearing witness to an imperial pride and rotting like a carcass, returning to the substance of the soil, rather as an aging double ends up being confused with the real thing), this fable would then have come full circle for us, and now has nothing but the discreet charm of second-order simulacra . . . The territory no longer precedes the map, nor survives it. Henceforth, it is the map that precedes the territory . . . [18]

But however much we may analyze him from a postmodern perspective, this does not make Verne himself a postmodern. While intent on mapping the globe in language, he would never have asserted that "the map . . . precedes the territory." It is more accurate to see Verne not as a precursor of anything at all, but as part of a general "shift in emphasis from narrativity to geography" that can be traced from Renaissance travel accounts to contemporary Nintendo games, both of which privilege spatial exploration over development of character or plot.[19] Verne stands at a crucial nineteenth-century juncture in this shift, where text-based accounts were giving way to visually-based ones. Because Verne came to the *voyages* out of a background in the theater, and he *staged* his novels in such an emphatic way, and consciously made the setting the leading element in them, his work has a striking visual intensity. He educated his audience in seeing a new world, the globe, through showing them the scenery and the poetry of the planet.

Verne's importance in cultural history is not as a precursor of postmodernity, but as a revelator of what was always inherent in modernity: the cultural project of replacing the given world by a human-created one of representation (whether scientific description, textual narrative, or some combination) that is capable of almost infinite manipulation. World alienation was never just a matter of conquering the given world, but was always intent on lifting off from it entirely.

The geobiography of Verne suggests some of the psychic and social forces that might have motivated this cultural project. His world alienation is part of a cycle of economic production, in which labor produced imagined and real space. This was a positive motivation: making space made money. At the same time, there was this negative motivation: the control of space kept at a distance the world of biological necessity—women, children, organic life, physical labor—all of which he found threatening and bewildering.[20] World alienation therefore involves more than the desire to distance oneself from the geographic surface of the earth. It is also motivated by the desire to distance oneself from the weight of the family, of history, of contingency and suffering.

If Verne's case illuminates the possible source of world alienation, even more clearly does it illuminate the consequences. His fascination with romantic technologies of technology and communication diverted his attention from other forms of technological development. Jean Chesneaux has stressed that in Verne's imagination, machines serve for travel, communications, comfort, and the general mastery of man over nature. With very few exceptions, they are not in the service of large industrial production. "In other words, the machines and mechanisms of Jules Verne *are not producers of surplus value*." They exploit the resources of nature rather than human labor.[21]

All the time, however, technologies of production were changing the landscape of the real world. This transformation dominates Verne's later novels. Critics agree that there is a darkening and thickening of his political and technological vision after the mid-1880s, when he was so afflicted by a series of painful losses—his mother, his mistress, his publisher Hetzel, his health—and worries about his son. In many of his later works, the triumphant conquest of space gives way to the destruction of place. They frequently portray a "city of perdition," a smoky. industrial city where environment and social damage go hand in hand.[22]

When place is ignored in imagination, it is more likely to be ruined in reality, because no one is paying attention. And when cultural attention is directed to faraway adventures and technological wonders, the near-at-hand may be relentlessly worked over by far less glamorous technologies. "On this planet triumphantly devoured by the Vernian hero," concludes Roland Barthes, the romantic obsessions of Verne's spleen-driven desperados highlight by contrast the basic health and sanity of the true proprietors of the world whose only concern is to adapt themselves as perfectly as possible to situations of which the complexity, not at all metaphysical nor even moral, involves very simply some piquant caprice of geography.[23] □

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'Look!' said the professor.

Dumbstruck like him, but markedly less happy, I read on the western side of the boulder, in runic characters gnawed by time, the thousand-times-accursed name:

Notes

1. Butor, "Le Point suprême et l'âge d'or à travers quelques oeuvres de Jules Verne," *Arts et lettres* (Special issue on Jules Verne), vol. 15 (1949): 3–31. Reprinted in *Répertoire*, vol. 1 (Paris: Éditions de Minuit, 1960), 130–62. See description in Vierne, 418.
2. The quote from *Cinq semaines* comes in chapter 26 (p. 209), and the "death" scene in *Cinq semaines* in Chap. 43. Arthur B. Evans, *Jules Verne Rediscovered: Didacticism and the Scientific Novel* (New York, Westport, CT, and London: Greenwood Press, 1988), 68, quotes and analyses some of these and other examples of Verne's "personification and anthropomorphisms" of technology.
3. Verne, *La Maison à vapeur*, Chapter x; quoted in de Noblet and Gillet in Bernard Roux, Le Printemps technologies de Jules Verner. *Un Amiénois visionnaire* (Amiens: Éditions Courrier Picard et Crédit Agricole de la Somme, 1985), 42.
4. Barthes, "Nautilus et bateau ivre," *Mythologies* (Paris: Seuil, 1957), 90 [full chapter 90–92. See also the discussion by Evans of Verne's vehicles as "buffers," support structures that provide enclosed and safe spaces for the protagonist/reader exploring new and distant environments (152–57).
5. Barthes, 90.
6. Ibid., 92.
7. "Nous habitons un monde nouveau, peuplé de nous seuls, le projectile! . . . Au-delà de nous, en dehors de nous, l'humanité finit . . . " *Autour de la lune*, chap. 3; see Simone Vierne's preface to *De la terre à la lune, suivi de Autour de la lune* (Paris: Garnier-Flammarion, 1978), 31.
8. Verne, *Autour de la lune*; chapter x. [Quote from Verne, *Works of Jules Verne*, vol. 3, Adventures of Captain Hatteras, A Trip from the Earth to the Moon, A Tour of the Moon, ed. Charles F. Horne (New York and London: Vincent Parke and Co., 1911), 246.]
9. Evans, 153, 155.
10. Raymond Williams, commenting on his book *Drama from Ibsen to Eliot* (1952), in *Politics and Letters: Interviews with New Left Review* (London: Verso, 1979), 205.
11. Pierre Vidal, "Les navires des *Voyages extraordinaires*," in *La Nouvelle Reve maritime*, numéro spécial "Jules Verne et la mer," 1984, 66–87; cited in Dumas, *Verne*, 144.
12. Dumas, *Verne*, 144. He proceeds to count the non-aquatic books: *L'Étoile du Sud*, *Le Chemin de France*, *César Cascabel*, and *Le Château des Carpathes*. See also Brosse, 59–60.
13. Verne, *Cinq semaines*, chap. 1 (Parke, ed., p. 15).
14. Dumas, "Quand Jules Verne voyageait," 215; Jean Chesneaux, "Jules Verne et la modernité: Des *Voyages extraordinaires* à nos années quatre-vingts," in Jean Bessière (ed.), *Modernités de Jules Verne* (Paris: Presses universitaires de France, 1988), 61 [full article 55–68]. See also Allott, 135, and P. Terrasse, "Jules Verne et les chemins de fer," in *Grand Album Jules Verne* (Paris: Hachette, 1982), 30–44.
15. Michael Heim, *The Metaphysics of Virtual Reality* (New York and Oxford: Oxford University Press, 1993), 155. He quotes Gibson's definition on p. 80 [from *Mona Lisa Overdrive* (New York: Bantam Books, 1988), 49.]
16. This is a phrase used by Peter Gabriel, as reported in the New York *Times*: "He believes that for musicians, artists and film makers, all connections will eventually lead to the information highway." 'But it's really an information ocean, not a highway,' he said. 'If you think of it as an ocean, then you have to consider the kind of navigation tools that are used, who builds the boats, who designs then and whether you're surfing or diving. If you have a message in the bottle, how do you actually get the bottle to the people who need it?" "At Lunch with Peter Gabriel," The New York *Times* (Wednesday, July 13, 1994), C10.
17. Jean Baudrillard, "Simulacra and Simulations," in Mark Poster (ed.), *Jean Baudrillard: Selected Writings* (Stanford: Stanford University Press, 1988), 166.
18. Ibid. (quoted in Jameson, 430, note 60).
19. Mary Fuller and Henry Jenkins, "Nintendo and New World Travel Writing," *Civitas: Cultural Studies at MIT*, vol. 3, no. 1 (Fall 1993), 1 [full article 1–6].
20. Cyberspace philosopher Michael Heim has named three features of the real world that distinguish it from virtual reality. One is morality/natality, the facts that we are born at a definite time into a definite family and have a definite end to our life. A second feature is temporality, "the built-in carryover of events from the past into the future, our memory, or history," so that events are unique and irretrievable. Finally, the real world is fragile and precarious, and frequently causes suffering (Heim, 136).
21. Chesneaux, *Jules Verne*, 39 [my translation, his italics]; see also 43.
22. Chesneaux, "Jules Verne et la modernité," in Bessière (ed.), 58.
23. Barthes, 91.

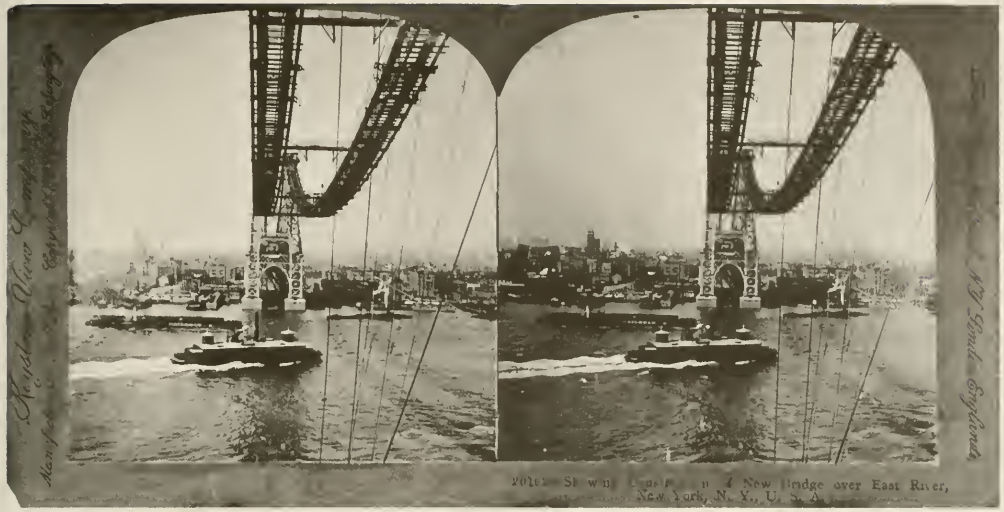
So what about replacing everything, that is, transplanting a human brain into a specially designed robot body? Unfortunately, it would leave untouched our biggest handicap, the limited and fixed intelligence of the human brain—Hans Moravec, Mind Children, The Future of Robot and Human Intelligence

OP/ED

THE CYBORG WITHIN US

Cambridge, Massachusetts: 1995

Do you remember Ol' John Henry? In a contest with a steam-shovel he dug his way through a mountain, staging for the last time the superiority of muscle over machine, and gave his life in the exchange. Ol' John Henry. That steam engine with its regulator and insistent logic of heat and motion gave rise to more intelligent machines. Now we are ready for a new folklore for the new folk populating the network and beyond. Hans Moravec's book of 1988, *Mind Children, The Future of Robot and Human Intelligence*, is among the more daft pronunciation guides for proponents of Artificial Intelligence and Artificial Life, however indistinctly the two may be differentiated. Moravec would like us to vividly imagine the rather promiscuous possibilities he has fantasized for our bodies (what William Gibson refers to in his canonical work, *Neuromancer*, as "the meat"). What Moravec has in mind is that we leave our bodies behind altogether as we prepare to become Mind Children, the progeny of highly sensitive self-replicating automata. All that our re-birth requires is the liberation of our mind from our flesh, gray matter and all, its contents perfunctorily evacuated by robotic surgeons. Moravec's lurid techno-fantasies are set apart from the body text of his book by *italicized* passages in which he adduces scenarios of our blithe a-corporeal future. As we begin to comprehend fully the significance of the cybernetic systems we operate and which in turn govern us, it is necessary to recognize that our "biggest handicap" is not that the brain is too small, slow, or inefficient. Rather, we have not yet come to terms with the body by means of which the brain is vitalized. I have amended some of Moravec's *slanted* text for strictly didactic purposes, as I am truly wed to what Moravec "leaves untouched": the mind and the body. What follows is not a précis of Moravec's book, but will rather suggest a number of hypertextual links (*renvois*) that might add to its comprehension. The connective tissue of this web could only be spun in a dyspeptic mind, which I no doubt possess. To give credence to my argument, I also feel it necessary to discuss my own robotic conversion.



First, my conversion. On the most recent of my frequent trips to the dentist, I was examined by Dr. R—, Dr. S—'s new associate, fresh out of dental school. As Dr. R— peered into my mouth, admiring the fillings and crowns Dr. S— had masterfully crafted (the man was meant to be a sculptor), Dr. S— said, "We are converting him." I initially took this in the narrow sense to mean that I was being brought into the fold of vigilant dental prophylaxis (flossing, massaging the gums, etc.). As Dr. S— looked at the X-ray and suggested the team's next move it became clear to me that something else more radical than paternal therapeutic reform was taking place. My teeth, originally grown of enamel and pulp, have been furrowed into and drilled away, subsequently replaced with gold and epoxy castings that are shaped like teeth, but do not look like them. My teeth are no longer of nature but not yet of culture, they are troubling hybrids. The X-rays show this all too clearly; my self-grown matter appears gray and gauzy while what is metal and impermeable to light appears white on the same film. The picture was no longer me, but contained white holes marking the replacement of used-to-be-me with better-than-what-was.

Like the penetrating probe of Moravec's robotic brain surgeon, this substitution was preceded by a visit to the periodontist who performed root canal and quite literally took the life out of the tooth, readying it for the crown. After the root canal the tooth stem remains but is no longer alive; a non-vital tooth aids in digestion, contributes to social intercourse through its part in a seemingly healthy smile, but has absolutely no life of its own. This point is important since in his drama of algorithmic modeling and biological obsolescence Moravec, like many A-Life advocates, is ultimately speaking about mimesis. They are looking for something that is life-like but not like life; what they find may well fall into disorder but it will not die, its consitutent parts reassimilated into the surrounding medium of matter and energy. The craft of dental prosthetics with its commitment to scientific realism is not to my mind different from the ultra, hyper-, and super- sensing and animating stuff that Moravec describes as replacing the body. If you consider how extraordinarily sensitive the tongue is (just work on a poppy seed stuck between your teeth, or lick something, or someone) you will see why the mouth is especially a place where you would want a proper fit.

The crown that is used to replace the tooth emerges from a rather involved process of approximation. A mold is made of the mouth by piling in a plastic compound on an electrically charged bit that is heated causing it to set. After it is removed a plaster positive is formed from this negative, and from this an oral-artist sculpts a new tooth. Dr. S— then places the tooth, a tenon fitted into the mortise that is the carefully carved gap in my mouth, and measures and examines the fixture (measure twice, cut once) removing it again and again to file and shapes it until it is smooth and right. Finally, the epoxy he uses

to attach the crown to the tooth stem is activated with an ultraviolet light, a brief flash that quickens the fix, the Big-Bang of dental cosmetics. Afterwards, the crown and I are one. The woman hygienist (sic semper tyrannis) who perhaps would rather be the dentist, armed with sharp pointed tools, scrapes away any excess cement and polishes the tooth to go. Doctor, assistant, and patient all become tangled in a hastily choreographed and ungainly play of tubes, drills, cuspidors and pain, holy pain, and much noise which focuses ever more closely on my mouth, a literal gold mine. All the while, in the back room sit the technicians who make this wonderful transformation possible. They are not seen but sometimes their instruments are heard. They are not paid as much as the dentist, after all it is his show and my mouth is its stage. I would give my I teeth to . . .

It might be objected that Moravec was not just talking about replacing body parts; in fact, he was suggesting a condition in which the social and mental effects of defective teeth, prostates, joints, breasts, eyes, etc. would cease to hamper the true functioning of the brain. But what is that functioning if not in great part the experience of those parts, one's own and those of another. And I do not mean this in the programmatic sense of substitution or transplant, but in the rather more promiscuous connotation which Moravec seeks to entice us with—sharing. The dentist's office is so poignant in this regard because it seizes our mind into full activity to deliver us from the pain that our body experiences there. It demands the ironic detachment from the body we wish improved; it causes us to register the worlds opened up in the body when we experience pain and the worlds closed down beyond that body when, because of the pain, what is beyond comes to seem trivial by comparison.[1] Despite Moravec's enthusiasms, the promise of mass disembodiment appears to me on the same register as mass extermination—the conscription of a people into the imperfect machinery of memory.

I wish I could make an argument about the mechanisms by which we can recall a caress or lessen a blow. It would reconstruct the psycho-geography that coordinates time, distance, and place and could account for the satisfactions and frustrations of the body that are not experienced in turn but all at once, immediately. It could be a matrix, a variously dense yet limitless field of possibility whose meaning would also include the rather narrow conception of a die or mold like that for forming teeth. One that produces what is missing from it out of an alchemic transformation of what is present within it, the mix activated by the light and heat of anticipation and desire. I am not talking about a 'brain in a box' that can be stimulated and made to feel anything; I am talking about the dense, thick familiarity of the body, along with the body of another, with all their glaring limitations, the risk of pain with the pursuit of pleasure. Our place in the matrix, or our illusory extraction from it, would result from additional libidinal investment or disinvolvement that constantly change its contour, pace, and the repetition of our attempts to file down and shape its castings to the proper fit. What is the name of my desire? It is compiled, assembled, and operating beyond where it can be addressed by A + B x C; it is accessible only with a calculus that is the subject of all those feverish dreams where I realize at the end of the semester that I never went to math class.

I do not have the time to contextualize all the variables so I am going to make a tabular shorthand for some of the body's possibilities, before advancing on Walt Whitman. The body survives constantly changing states of mind; it is for them a repository without being prior or given but like anything else in nature must be made and imagined. To achieve this state Moravec would have us put on digitally enhanced glasses or wear highly sensing "magic clothes." But how about this for a suggestion: take off your clothes and open up your eyes. There is something out there, and if there isn't, you will feel it real bad inside. So much for our post-modern skepticism. These are some of the signs that appear on the boundary between mind and body but are not strictly locatable:

longing

anticipation

recollection

desire

envy

mystery

If the above has dealt more extensively with pain, in what follows I want to discuss another possibility of the body—pleasure. Deep pleasure. A thrill which is not the pure receptivity that is flatly mimetic—one thing perfectly approximating another—that is Moravec's dream. I am suggesting the steady calm of reconciling oneself to another in something that is active and vigorous.

The title page of Walt Whitman's life-work 'Leaves of Grass' of 1855 does not bear his name on its title page but only states its origin, Brooklyn. The opposing frontispiece is an engraving of the poet in his loose fitting shirt with its collar parted, one hand is in his pocket and the other resting on his hip, arm bent outward. His left leg juts out slightly, his tipped hat accentuates the slight tilt of his head. He appears relaxed and knowing, a cool combination of confidence and willingness.

This is what Whitman says in "Song of Myself," 'myself' being a category that Moravec wants to preserve with a bewildering array of substitutions but at the same time diminishes telling us we overestimate its very individuality:

> I Celebrate Myself,
> And what I assume you shall assume,
> For every atom belonging to me as good belongs to you.

What does Whitman suppose of our own acquiescence to this project? What belongs to one or the other and who shall consolidate or disperse this ethereal union? How does assumption become so animating when we use it in the familiar sense to suggest what is merely accepted?

Loafe with me on the grass . . .
loose the stop from your throat,
Not words, not music or rhyme I
want . . . not custom or lecture,
not even the best,
Only the lull I like, the hum of
your valved voice.

I mind how we lay in June, such
a transparent summer morning;
You settled your head athwart
my hips and gently turned over
upon me,
And parted the shirt from my
bosom-bone, and plunged your tongue
to my barestript heart,
And reached till you felt my
beard, and reached till you held my feet.

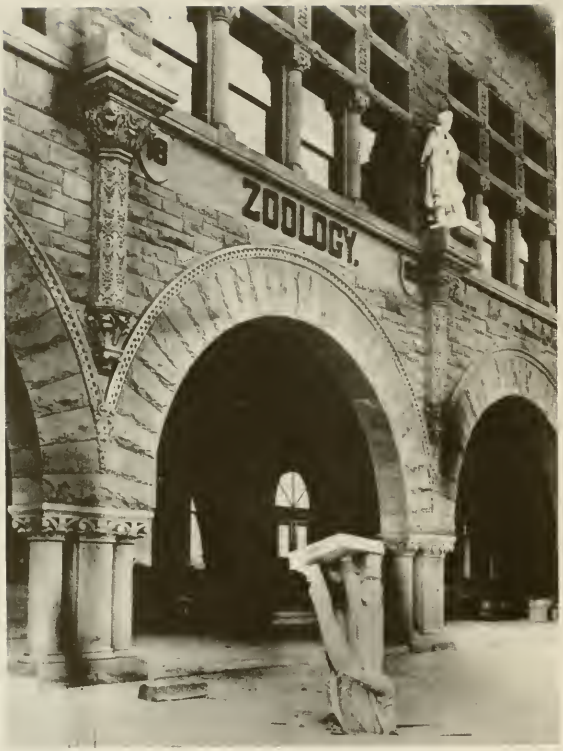
Whitman minds the intense sensation of being with another. We might ask again, what is the appeal of leaving our bodies behind if our bodies can mind others' bodies, brushing against them like leaves of grass. This handicap of the mind is not a tragedy but a cause for celebration. I present Whitman's passage as an article of faith in the need, use, care, and pleasure of the body. Whitman did not have in mind transporter rooms and transistors, even when speaking of the "body electric," when he wrote that "For every atom belonging to me as good belongs to you." He made clear that the ever more rudimentary Brooklyn Ferry, in its continued trade, would ensure that his vision, feeling, and elation would "ever so many hundreds of years hence," be experienced by riders between the shores.

In her essay "A Cyborg Manifesto," Donna J. Haraway writes of the potential of irony for allowing us to trespass the uncertain boundaries of our second nature. "Irony is about contradictions that do not resolve into larger wholes, even dialectically, about the tension holding incompatible things together because both or all are necessary and true. Irony is about humor and serious play."[2] With Moravec's book we confront again the historic difficulty of speaking about the mind and body as a person or entity, of "holding incompatible things together because both or all are necessary and true." The connection between mind and body is so laden in history and as to be one of the major preoccupations of our nature/culture. Perhaps we should renominate ourselves *homo vulnera vitae* (wounded life) and admit of the possibility of loss instead of mechanically overcoming it through flights of sapience.

Do I stand in the way of progress? I would not have cheered for John Henry simply because I would have wanted to see his poor soul get out of the mine, whatever the outcome of the race says about the future of human potential. Moravec's happy picture does not even begin to take into account all those who toil away to keep the machinery running. We have a digital highway on the horizon but a labor movement that has been put on the road out of town. As for my own labors, on the 'Interactivity Matrix' printed in the first issue of the magazine *Wired*, the graph of 'Vividness' and 'Interactivity' ranks Gibson's Cyberspace next to the top and *books* at the very bottom. For the matrix I am proposing, read to someone from "Leaves of Grass," "loose the stop from your throat," "You settled your head athwart my hips and gently turned over/upon me," and then readjust the coordinates of the graph accordingly. If you feel no need to do so, then indeed let me put on my magic glasses and lets start drilling away at your precious brain. Or should we start with your teeth? □

NOTES

1. See, Elaine Scarry, *The Body in Pain* (New York: Oxford University Press, 1985).
2. Donna J. Haraway, "A Cyborg Manifesto, Science, Technology, and Socialist-Feminism in the Late Twentieth Century" in *Simians, Cyborgs, and Women: the Reinvention of Nature* (New York: Routledge, 1991), p. 149.



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